UNITED STATES DEPARTMENT OF AGRICULTURE

BULLETIN No. 466

Contribution from the Bureau of Chemistry
CARL L. ALSBERG, Chief

Washington, D. C. PROFESSIONAL PAPER November 3, 1917

MAPLE SUGAR: COMPOSITION, METHODS OF ANALYSIS, EFFECT OF ENVIRONMENT.

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CONTENTS.

INTRODUCTION.

A previous publication[1] of the Bureau of Chemistry dealing with the manufacture of maple-sap sirup gives the distinguishing features of sap sirup and sugar sirup, as well as the results of the chemical examination of 481 samples of sap sirups. The present bulletin deals with the methods of analysis and the composition of maple sugars examined in the former Sugar Laboratory of the Bureau of Chemistry in connection with the previous report and of samples collected during the seasons 1910, 1911, and 1912. It is believed that this report may be useful to food chemists who are called upon to examine maple products.

DEFINITIONS.

As maple sirup is the sap of the live maple tree concentrated to a standard density, with or without the addition of the usual clarifying agents, maple sugar is the solid product resulting from the further concentration of the sirup or of the sap, with or without the addition of clarifiers, and without the loss of any of its constituents other than

[1] U. S. Dept. Agr., Bur. Chem. Bul. 134.

the solids precipitated by the concentration. United States Department of Agriculture, Office of the Secretary, Food Inspection Decision 161, January 3, 1916, states that "*Maple sugar, maple concrete,* is the solid product resulting from the evaporation of maple sap or maple sirup. *Maple sirup* is sirup made by the evaporation of maple sap or by the solution of maple concrete, and contains not more than thirty-five per cent (35%) of water and weighs not less than eleven (11) pounds to the gallon (231 cu. in.)."

The maple sugar of commerce may be divided into soft or hard sugar or into stirred sugar (sometimes called grain sugar), cake sugar, and tub sugar.

The terms hard sugar and soft sugar apply to the relative hardness of the product; a sugar is said to be hard when it is difficult to break the cake and soft when the cake is easily broken. Hard sugar contains less moisture than soft sugar and is produced by boiling to a higher temperature; that is, by boiling it longer. Determinations of moisture in these two grades are given in tabular form on page 39.

The terms stirred, cake, and tub sugar apply to the form in which the finished product is placed upon the market.

Stirred or grain sugar, sometimes called "crumb" sugar, derives its name from the fact that it is concentrated to a rather high degree, then stirred during cooling and crystallization. The finished product resembles the ordinary commercial brown sugar, and as a rule is dry and slightly lumpy. The color varies from off white to light brown, although there are some dark varieties. It is not often found on the open market, being made mostly for consumption in the farmer's home. Certain sections of the country, however, as Pennsylvania, produce a large quantity of their maple products in this form.

Cake sugar, which may be either soft or hard, is so named because it is molded in the form of cakes varying in size from the 1-ounce cakes of the fancy confectionery trade to those weighing several pounds. The fancy cakes as a rule dissolve readily in the mouth, while the hard cakes are not easily broken by the teeth and can be shipped without cracking. The larger cakes are known as brick sugar. The color varies from off white to black. Imported maple sugar is usually very dark colored. The darker varieties are strong flavored and have more or less taste of caramel.

Tub sugar may be classed as a soft sugar. It gains its name from the fact that the makers concentrate their sirup to the desired density, cool slightly, and then run it into tubs of from 10 to 50 pounds capacity, with an average of 25 pounds. These containers are generally wooden, although tin is sometimes used for fancy trade. Much of the tub sugar is of a low grade and very dark. Often it is in a "mushy" condition and drains badly.

SAMPLING.

In the case of grain sugar or cake sugar that is hard and dry, sampling is comparatively easy, but with tub sugar or wet cake sugar there is more difficulty, because the liquid portion has drained to some extent and may have left practically pure sucrose. Maple sugar is principally sucrose, or the sugar of commerce, with a mother liquor surrounding the crystals which gives it its particular characteristic qualities. Were the mother liquor removed completely from the crystals of sugar, one would have the ordinary sugar of commerce, granulated sugar or sucrose. Maple sugar brings its high price not on account of the sugar it contains but because of the agreeable flavoring substances which are present in the mother liquor. It is easily argued, then, that if this mother liquor is removed in part the product is not maple sugar, and a person buying it would not be buying maple sugar. With this point of view, it is necessary in sampling a tub of maple sugar or of any soft sugar to see that the product is thoroughly mixed before a sample is drawn, and that the sample represents both the sugar and the proportionate quantity of the mother liquor.

METHODS OF ANALYSIS.

It is the general practice in the manufacture of maple sugar not to skim or remove the mineral matter which is separated during the boiling and concentration of the sirup; many makers cake the skimmings and settlings, considering that such a procedure does not injure the product in any way and gives it a larger volume. In the production of fancy cake sugar the manufacturer usually skims and removes all sediment carefully before the final boiling for the caking of the sugar. It will be readily seen that the sugar made without skimming or filtration will have a much higher ash content than that which has been carefully cleansed before caking. In order to place all sugar samples upon a comparative basis, it is necessary in the preparation of the sample for analysis to dissolve the sugar and remove the suspended mineral and organic matter. Samples of maple sugar, especially of that made from skimmings and settlings, have been found with an ash content as high as 3 per cent, while sugar made from carefully cleansed sirup sometimes contains as little as 0.77 per cent. If the analysis were made on the sugar itself, it would be possible to add nearly two-thirds white sugar and make a product which, according to the ash, would not be suspected of adulteration, but if this adulterated sugar were made into sirup and the substances foreign to the sugar held in suspension were removed, the ash content would be so reduced that adulteration of two-thirds white sugar would be readily seen.

Jones,[1] recognizing this, recommended that all maple sugar be dissolved to a standard sirup of 11 pounds to the gallon, filtered, and the sirup analyzed, to effect a more certain determination of the presence or absence of adulterants. By this treatment, even with the highest grades of pure maple sugar, he has never obtained a sirup having chemical characteristics which would place it in the list of adulterated products. He states that "It would seem, therefore, that a certain minimum amount of ash can not be removed from pure sugar or sugar made into sirup by the ordinary methods of filtration and that even the slow and complete filtering which is effected by this method fails to remove sufficient ash from the pure goods to admit even a suspicion of adulteration."

The effect of the treatment just described is readily seen in Table I, where the results of the eight samples of maple sugar analyzed as sugar and then analyzed in the sirup condition are tabulated, the individual determinations in all cases being calculated to the moisture-free basis.

TABLE I.—*Analysis of maple sugar as sugar and as sugar sirup.*

Sample No.	Sugar.				Sirup.			
	Total ash.	Insoluble ash.	Soluble ash.	Winton lead number.	Total ash.	Insoluble ash.	Soluble ash.	Winton lead number.
	Per cent.	*Per cent.*	*Per cent.*		*Per cent.*	*Per cent.*	*Per cent.*	
1	0.93	0.42	0.51	2.12	0.87	0.32	0.55	2.18
2	.89	.36	.53	2.14	.79	.29	.50	2.05
3	1.28	.63	.65	3.28	.84	.23	.61	2.36
4	.98	.38	.60	2.51	.82	.24	.58	2.40
5	.95	.42	.53	2.46	.79	.24	.55	1.93
6	1.22	.67	.55	3.25	.83	.23	.60	2.29
7	1.35	.76	.59	3.38	.85	.23	.62	2.35
8	1.20	.66	.54	3.16	.84	.23	.61	2.15
Average	1.10	.54	.56	2.79	.83	.25	.58	2.21

In the sugar state the total ash varied from 1.35 to 0.89 per cent, a variation of 0.46 per cent, with an average of 1.10 per cent, while after making the sugar into sirup the range was from 0.87 to 0.79 per cent, or a variation of only 0.08 per cent, with an average of 0.83 per cent. In the filtration process 0.27 per cent of ash had been removed, which corresponds practically to the loss in insoluble ash. The soluble ash remained practically the same, corroborated again by the fact that analysis of the precipitate gives only small percentages of sodium or potash salts. The lead number decreased from an average of 2.79 to 2.21 per cent, with variations of the sugar from 3.38 to 2.12, or 1.26 per cent, and of the sugar sirup from 2.40 to 1.93, 0.47 per cent. Here again by analyzing the product in the form of a sirup the maximum and minimum results are brought closer together and adulteration is more easily detected. These figures agree with those obtained by Jones.[1]

[1] Vt. Agr. Exp. Sta., 17th Ann. Rpt. (1904), p. 453; 18th Ann. Rpt. (1905), p. 327.

TABLE II.—*Comparison of sugar and sirup results (Jones).*[1]

Maple sugar.		Sirup from same sugar.		Calculated to dry basis from approximately 65 per cent solids.	
Total ash.	Insoluble ash.	Total ash.	Insoluble ash.	Total ash.	Insoluble ash.
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
0.80	0.34	0.56	0.22	0.86	0.34
1.08	.64	.52	.18	.80	.28

[1] Jones does not state that the figures on "Maple sugar" were calculated to a dry basis. The figures on "Sirup from same sugar" are on a basis of 11 pounds to the gallon.

A case has never been noted in which by this treatment the sirup produced gives all analytical figures below the minima discussed on page 45 unless the maple sugar has been adulterated by the use of some other sugar.

Trials were also made to determine whether making into a sugar a second time tended to reduce these figures. Samples of sugar sirups were converted into sugar and then redissolved to a sirup of standard density. As shown in Tables I and II, this treatment does not materially change the results.

TABLE III.—*Analysis of sugar sirups converted into sugar and redissolved to sirup.*

Sirup from first sugaring.				Sirup from second sugaring.			
Total ash.	Insoluble ash.	Lead number.	Malic acid value.	Total ash.	Insoluble ash.	Lead number.	Malic acid value.
Per cent.	*Per cent.*			*Per cent.*	*Per cent.*		
0.78	0.23	1.86	0.59	0.77	0.23	1.88	0.60
.87	.24	2.14	.76	.91	.24	2.22	.78
.83	.27	2.22	.73	.82	.28	2.25	.74
.77	.24	1.86	.60	.76	.25	1.87	.62

The removal of this precipitated mineral and organic matter, spoken of in commercial manufacture as the refining of the maple sugar, is simply the removal of suspended matter contained in the sugar sirup. As shown by Table III, this does not tend to reduce the analytical figures below the minimum for pure products.

In a later publication [1] Jones calls attention to the effect of concentration on the percentage of the ash and also malic acid value. As a liquid product is concentrated, its power of holding salts in solution becomes less; hence one expects to find less ash in a more concentrated solution than in one of lower concentration. This is true of maple, as shown in Table IV.

[1] Vt. Agr. Exp. Sta. Bul. 167, p. 466.

TABLE IV.—*Effect of concentration of sirup on ash and malic acid values (Jones).*

Concentration.	Ash.			Malic acid value.
	Total.	Soluble.	Insoluble.	
	Per cent.	*Per cent.*	*Per cent.*	
Average of 84 sirups having over 34 per cent water	1.02	0.45	0.57	1.00
Average of 42 sirups having from 30 to 34 per cent water	.80	.48	.32	.71
Average of 25 sirups having less than 30 per cent water	.77	.49	.28	.66

[1] Vt. Agr. Exp. Sta. Bul. 167, p. 466.

It is necessary, then, to use care not to concentrate a sample of sirup made from the sugar under examination beyond a certain point, as there might be a precipitation of material which would cause the analyst to believe the sample was adulterated. The data contained in Table V show the likelihood of such an occurrence.

TABLE V.—*Effect of addition of water on ash and malic acid values (Jones).*[1]

Sample No.	Original sirup.					Water added and heated.				
	Moisture.	Ash.			Malic acid value.	Moisture.	Ash.			Malic acid value.
		Total.	Soluble.	Insoluble.			Total.	Soluble.	Insoluble.	
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*		*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	
105	30.53	0.79	0.54	0.25	0.61	39.21	0.81	0.53	0.28	0.63
113	29.99	.75	.50	.25	.73	37.25	.96	.55	.41	.75
104	29.46	.69	.47	.22	.60	35.40	.77	.43	.34	.74
107	27.90	.71	.50	.21	.58	35.05	.79	.54	.25	.61
108	29.64	.65	.45	.20	.49	33.27	.75	.52	.23	.52
114	30.69	.71	.49	.22	.56	35.75	.92	.65	.27	.62
110	30.94	.67	.44	.23	.65	35.62	.81	.56	.25	.61
115	31.04	.72	.51	.21	.62	38.00	.87	.61	.26	.60
91	26.75	.72	.44	.28	.90	35.95	.78	.51	.27	.61
111	28.29	.77	.53	.24	.67	39.40	.86	.60	.26	.66
117	30.70	.74	.51	.23	.61	35.75	.87	.53	.34	.64
Average	29.63	.72	.49	.23	.64	36.42	.83	.55	.28	.63

[1] Vt. Agr. Exp. Sta. Bul. 167, p. 471.

The original samples were concentrated in each case below the 65 per cent solid content and showed low analytical figures in most cases. Taking these same samples, with the sediment contained therein, and adding water and boiling again to about a 35 per cent moisture content, the analytical figures, with the possible exception of No. 108, where the second concentration is below 35 per cent, are well within the bounds of pure products. Average figures show that changing the concentration from 29.63 per cent water to 36.42 per cent has increased the ash from 0.72 to 0.83 per cent, and the insoluble ash from 0.23 to 0.28 per cent, but has not changed the malic acid content. From this, it is seen that in concentrating the maple sugar sirup for analysis the dry substance of the finished sirup should not be much over 65 to 66 per cent.

COLLECTION OF SAMPLES.

Part of the samples were collected by the authors and part by the official inspectors of the department from makers of maple products. The authenticity of these samples can not then be doubted.

PREPARATION OF SAMPLE.

All chemical examinations were made on a sirup prepared by dissolving 100 grams of the maple sugar in at least 200 cc of water, and boiling the solution down to a consistency of 65 per cent of solid matter. When an undue amount of sediment rendered the solution cloudy, it was boiled until the sirup consisted of about 30 per cent dry matter, after which it was filtered and concentrated to the 65 per cent basis. These solutions were kept at a temperature of 20° C. for two days, during which time the sediment settled, leaving a clear liquid for the determinations.

The physical points ascertained were color of sugar, color of sirup, and taste. The chemical examination consisted in the estimation of sucrose, invert sugar, ash, lead number, and malic acid value, and qualitative test for tannin. A moisture determination was made on a few sugar samples.

COLOR.

Sugar.—The determination on sugar, at best only approximate, was made by comparison with the Dutch standards of color. Eighteen standard sugars, varying from the very dark brown grade of No. 8 to the slightly yellowish white of No. 25, are contained in square glass bottles, which are filled and sealed by an association of sugar brokers in Amsterdam, Holland. As originally prepared, this set of colors was used by the Dutch to grade moist sugars coming from their possessions in the East India Islands, Java, etc. New sets identical in color with the first standards are prepared each year. Although grain maple sugar could be very readily compared, it was necessary to break up the cake or lump sugar and compare the average color of the broken surface with the standards. In most cases this color was practically that of the outside, but in some instances the fracture was almost white.

Sirup.—The set of standard colors employed in the grading of maple-sap sirup [1] was used in this determination.

TASTE.

The sirups were tasted by two persons, who graded each sample as good, poor, or rank.

MOISTURE IN SIRUP.

The Abbé heatable prism refractometer and the table of Geerlig [2] were used for this determination.

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[1] U. S. Dept. Agr., Bur. Chem. Bul. 134, p. 15, pl. I.

[2] U. S. Dept. Agr., Bur. Chem. Cir. 43, p. 7; U. S. Dept. Agr., Bur. Chem. Bul. 122, p. 169; Jour. Amer. Chem. Soc., 30 (1909), pp. 1443-51.

SUCROSE.

Sucrose was determined from the direct and invert polarization, by the Clerget formula,[1] using the factor 142.66 and hydrochloric acid as the hydrolyst. The results on a number of samples where invertase was the hydrolyst were identical with those obtained with the acid inversion.

INVERT SUGAR.

Munson and Walker's method and tables[2] were used. The procedure, which is the same as applied to the sap sirups, is given on page 16 of Bureau of Chemistry Bulletin 134.

ASH.

Five grams of the sample were ashed in a platinum dish in an electric oven in the usual way.[3] After ashing, a few drops of ammonium carbonate solution were added, the whole evaporated, ignited, and reweighed. The same procedure was followed in the case of insoluble ash. Alkalinity determinations of the soluble and insoluble ash were also made by the usual method.

In valuing maple products, the percentage of total ash is important as well as difficult to ascertain, so that the utmost care is necessary in carrying out this determination. Table VI shows determinations of ash on the same sample: (1) By burning over a free flame at a low heat and again at a red heat; (2) by burning in a muffle at a low and again at a high heat; (3) by burning in an electric oven at ordinary temperature. Following the results in the table are the same determinations after treatment with ammonium carbonate and reignition.

TABLE VI.—*Effect of method of burning on ash content.*

[Not calculated to dry basis.]

Experiment No.	Sample No.	Burned.	Temperature.	Ash.[4]	Ash after adding ammonium carbonate and heating.[4]
				Per cent.	*Per cent.*
1	8337	Free flame	Low	0.55	0.55
		....do	High	.50	.54
		Electric muffle	Low	.53	.54
		Gas muffle	Low	.54	.54
		....do	High	.49	.54
2	9235	Free flame	Low	.51	.50
		....do	High	.44	.51
		Electric muffle	Low	.52	.51
3	8337	Free flame	Low	.53	.53
		....do	High[5]	.31	.34
4	8512	Free flame	Low	.46	.46
		....do	High[5]	.37	.40
5	8554	Free flame	Low	.48	.48
		....do	High[5]	.40	.42
		Electric muffle	Low	.47	.47

[1] U. S. Dept. Agr., Bur. Chem. Bul. 107, Rev., p. 41.
[2] U. S. Dept. Agr., Bur. Chem. Bul. 107, Rev., p. 241.
[3] U. S. Dept. Agr., Bur. Chem. Bul. 134, pp. 16–17.
[4] Average figures.
[5] Temperature much higher than in the first two experiments.

In experiments 1 and 2 the results of burning in the three different ways are the same when the heat is low. When, however, the heat is increased, the percentage drop is 0.05 per cent in experiment 1 and 0.07 per cent in experiment 2, but the addition of ammonium carbonate brings the results back to the normal. In these two cases the extra heating has caused the formation of the oxid from the carbonate, but has not volatilized any of the ash. Repeating experiment 1 with a much greater heat, the ash drops 0.22 per cent and comes back only 0.03 per cent when moistened and reburned. Similar results were obtained in experiments 4 and 5, in both of which the percentage of ash did not come up to the normal by heating with ammonium carbonate. All three show the volatilization of some of the ash.

This all shows the necessity of using the utmost care in carrying out this determination. A very dull red is the highest to which an ash should be heated; then ammonium carbonate should be added and the dish reheated for true results.

LEAD NUMBER.

Two determinations of the lead number were made, using basic lead acetate solution in both. The lead number using normal lead acetate, as described in Bureau of Chemistry Bulletin 134, page 17, was not determined on these samples. The ordinary Winton lead number determination[1] was made and also the modification by S. H. Ross,[2] which is as follows:

Transfer 25 grams of the sirup to a 100 cc flask, using about 25 cc of distilled water; add 10 cc of potassium sulphate solution (7 grams per liter),[3] then 25 cc of lead subacetate solution of the strength specified by Winton. Make up to the mark, shake thoroughly, and allow to stand 3 hours. Filter, rejecting the first portion of the filtrate. Pipette off 10 cc of the clear filtrate into a 250-cc beaker, dilute to 50 cc, add 2 cc of 20 per cent sulphuric acid and 100 cc of 95 per cent alcohol. Let stand overnight, filter off the lead sulphate on an ignited, weighed Gooch crucible, wash with 95 per cent alcohol, dry, ignite at low redness for 3 minutes in a muffle or over a burner, taking care to avoid reducing cone of the flame, and weigh. Run a blank in exactly the same way, substituting 25 grams of a pure cane sugar sirup (66 per cent sucrose content) in place of the sirup to be tested.[4] Subtract the weight of the lead sulphate, obtained from 10 cc of the sirup test filtrate, from that obtained from 10 cc of the cane sugar sirup blank filtrate. The remainder, expressed in grams and multiplied by 27.325, gives the modified Winton lead number.

In both of these tests the composition of the lead subacetate solution is of the greatest importance, as it greatly influences the lead number. The average results of the basic lead acetate and normal lead acetate lead number taken from the work on sap sirups,[5] 2.70

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[1] U. S. Dept. Agr., Bur. Chem. Bul. 134, p. 17.
[2] U. S. Dept. Agr., Bur. Chem. Cir. 53.
[3] Freshly boiled distilled water should be used throughout.
[4] Do not use acetic acid in this blank; acidified blank is suggested for use only with original Winton method.
[5] U. S. Dept. Agr., Bur. Chem. Bul. 134, p. 89.

standing for the basic solution and 0.79 for the normal lead, indicate what may happen when the basicity of the acetate is changed. Browne has called attention to the fact that the basicity of the lead acetate affects the polarization and also that by digestion of varying amounts of neutral lead acetate and litharge at least three well-defined subacetates may be prepared.[1] Changes in treatment as to temperature and length of time of heating and also quantity of the two ingredients may form any one of these or a mixture of two.

An attempt was made to prepare solutions of these different basic lead acetates by varying the amount of lead oxid and the manner of solution as shown in Table VII. After the solutions were made up they were diluted to the same Brix as Winton's solution and a layer of heavy oil placed on top. The alkalinity and amount of lead were determined in each.

TABLE VII.—*Effect of method of preparation on basicity of lead acetate solution.*

Solution No.	Lead acetate.	Litharge.	Water.	Solution treatment.	Brix reading.	Nitric acid.	Lead.	
	Grams.	*Grams.*	*Cc.*		*Degrees.*	*Cc N/10 acid per 10 cc.*	*Per cent.*	*Grams per 2.5 cc.*
1	37.9	22.3	330	Stood a week; shaken.	15.60	30.15	5.70	0.1426
2	37.9	44.6	330	Solution lost				
3	75.8	22.3	330	Stood a week; shaken.	15.80	18.55	5.59	.1398
4	Horne's dry lead subacetate dissolved.				15.60	26.25	5.82	.1454
5	43.0	13.0	1,000	Boiled half hour	16.20	26.00	5.68	.1421
6	37.9	22.3	330	Do	15.77	27.50	5.80	.1449
7	75.8	22.3	330	Do	15.87	19.60	5.73	.1433
8	Neutral lead acetate, saturated solution.				15.87	2.00	5.44	.1359

The lead numbers of six samples of maple sirup were determined, using these seven solutions. The results appear in Table VIII.

TABLE VIII.—*Effect of basicity of lead acetate solutions upon the lead number.*

Sample No.	Lead solution number.						
	1	3	4	5	6	7	8
1	1.49	1.13	1.29	1.31	1.40	1.13	0.29
2	1.74	1.34	1.42	1.51	1.62	1.27	.36
3	1.79	1.41	1.57	1.56	1.72	1.39	.36
4	1.61	1.29	1.37	1.46	1.55	1.26	.34
5	2.00	1.47	1.64	1.70	1.80	1.41	.39
6	1.86	1.40	1.58	1.63	1.78	1.47	.37
Average	1.75	1.34	1.48	1.53	1.64	1.32	.35

Solution 4, the one usually employed, consisted of 3 parts of lead acetate to 2 parts of lead oxid. Solution 5 was carefully prepared by a method that should give this acetate. The results obtained from solutions 4 and 5 agree fairly well, the difference between the averages being only 0.05. Solutions 1 and 6 give results that are

[1] U. S. Dept. Agr., Bur. Chem. Bul. 122, p. 223.

much above the true lead number, while solutions 3 and 7 are below the true results. Solutions 1 and 6 contain more litharge in proportion to lead acetate than solutions 3 and 7, and likewise show a greater alkalinity. The alkalinity of the solution plays an important part, for when there is practically no alkalinity, as in No. 8, the lead number drops to an average of 0.35.

By preparing the solution of basic lead acetate strictly according to the method outlined in Bureau of Chemistry Bulletin 107, Revised, or in Winton's original method, or by solution of Horne's dry lead subacetate, the results of analysis should be comparable and easily duplicated. The acidity of the sample itself has little effect on the lead number, as shown in Table IX.

TABLE IX.—*Winton lead number of sirup before and after neutralization.*

[Not calculated to dry basis.]

Sample.	No. 8451.	No. 9235.
Straight sirup	1.75	1.49
Sirup after neutralization	1.78	1.56

In both samples the lead number was determined on the original sample and again on the same sample after neutralizing the acidity with tenth-normal potassium hydroxid, using phenolphthalein as an indicator. The acidity in one case, No. 8451, equaled 1 cc, in the other, No. 9235, 3 cc, of the tenth-normal potassium hydroxid to 100 cc. The neutralization increased the lead number by only 0.03 and 0.07, respectively.

MALIC ACID VALUE.

The calcium acetate method proposed by Cowles [1] was used for this determination. In the Bureau's previous work, it had been found that the blanks with calcium acetate were more even and the procedure indicated for this method gave a good precipitate which settled easily. The procedure is as follows:

Weigh 6.7 grams of the sample in a sugar dish, transfer to a 200-cc beaker with 5 cc of water, add 2 cc of a 10 per cent calcium acetate solution, and shake. Stir in 100 cc of 95 per cent alcohol and warm the solution until the precipitate settles, leaving the supernatant liquid clear. Filter off the precipitate and wash with 75 cc of 85 per cent alcohol, dry the filter paper, and ignite in a platinum dish. Add 10 cc of tenth-normal hydrochloric acid and warm gently until all the lime dissolves. Cool and titrate back with tenth-normal sodium hydroxid, using methyl orange as an indicator. One-tenth of the number of cubic centimeters of tenth-normal acid is the malic acid value. Run a blank determination with each set of determinations, using the same amount of reagents, and subtract the result obtained from the malic acid number.

[1] Jour. Amer. Chem. Soc., 30 (1908), p. 1285.

TANNIN REACTION.

A test for the presence of tannin was made in all of the samples by the ferric chlorid reaction as described in Bureau of Chemistry Bulletin 134, page 18.

RESULTS OF ANALYSIS.

The results of analysis of the samples, given in Table X, are arranged by States and counties. The location of the county in the State is shown by the usual symbols, namely, □ center, -□ west of center, ⌐□ southwest of center, etc. The results of the chemical examination have been calculated to the dry basis for better comparison. Averages have been made for the samples from the individual States, from Canada, and from the United States as a whole, as well as for all of the samples collected.

TABLE X.—*Results of physical and chemical examination of maple-sugar samples.*

[Calculated to dry basis.]

INDIANA.

Serial number and county or district.	Physical properties. Color. Sugar.	Color. Sirup.	Taste.	Chemical analysis. Sucrose (Clerget).	Invert sugar.	Undetermined.	Total ash.	Soluble ash.	Insoluble ash.	Soluble ash / Insoluble ash.	Alkalinity. Soluble ash.	Alkalinity. Insoluble ash.	Alkalinity. Soluble ash / Insoluble ash.	Tannin reaction.	Lead number. Winton.	Lead number. Ross.	Malic acid value.	Serial number.
Clinton□:				*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*		*Cc.*	*Cc.*						
8437	16	11+	Fair	85.60	9.53	3.69	1.18	0.83	0.35	2.37	103	99	1.04	None	3.86	4.66	1.12	8437
8438	14	14	do	81.94	11.25	5.84	.97	.66	.31	2.13	80	80	1.00	do	2.82	3.68	.88	8438
8439	16	10	Good	91.96	4.15	3.00	.89	.64	.25	2.56	72	62	1.16	do	2.50	3.23	.81	8439
Hamilton□:																		
8443	(1)	10+	do	92.75	2.29	3.80	1.16	.70	.46	1.52	89	113	.78	do	2.84	3.66	1.09	8443
8444	(1)	9	Fair	92.58	3.33	3.25	.84	.60	.24	2.50	74	61	1.21	do	2.17	3.09	.76	8444
8445	(1)	9	do	91.86	3.88	3.26	1.00	.71	.29	2.45	84	87	.96	do	3.05	3.71	1.02	8445
8446	(1)	11+	do	83.00	12.29	3.74	.97	.72	.25	2.88	89	72	1.23	do	2.73	3.59	.89	8446
Johnson□:																		
8458	(1)	10	do	90.10	5.26	3.56	1.08	.77	.31	2.48	89	95	.93	do	3.09	4.14	1.05	8458
8459	(1)	8	Good	94.25	1.75	3.09	.91	.68	.23	2.95	82	70	1.17	do	2.52	3.01	.79	8459
Lawrence□:																		
8457	(1)	7	do	95.11	1.21	2.56	1.12	.89	.23	3.87	103	75	1.37	do	2.94	3.75	1.08	8457
Madison□:																		
6394	9	20+	Burned	86.03	12.13	.26	1.58	.81	.77	1.05	96	146	.66	Trace	4.09	3.73	1.24	6394
Marion□:																		
8473	(1)	11+	Fair	92.12	3.94	2.72	1.22	.69	.53	1.30	86	126	.68	None	2.81	3.91	.83	8473
8474	(1)	13	do	85.20	9.08	4.54	1.18	.62	.56	1.11	75	145	.52	do	3.55	4.20	1.18	8474
8475	(1)	12	Poor	86.27	10.56	1.70	1.47	1.06	.41	2.58	108	95	1.14	do	4.43	4.55	1.27	8475
Morgan□:																		
8386	21	7+	Good	92.95	2.86	3.23	.96	.67	.29	2.31	93	66	1.41	do	3.07	3.55	.99	8386
Putnam□:																		
8469	(1)	11	Fair	91.97	4.28	2.55	1.20	.63	.57	1.10	79	149	.53	do	3.40	4.09	1.26	8469
8470	(1)	10+	do	93.29	3.20	2.60	.91	.68	.23	2.95	90	69	1.30	do	2.62	3.51	.90	8470
8471	(1)	9	do	90.76	4.82	3.49	.93	.62	.31	2.00	79	85	.93	do	2.82	3.60	.94	8471
8472	(1)	9	Good	95.34	1.41	2.36	.89	.66	.23	2.87	91	67	1.36	do	2.39	3.21	.83	8472
Average (19)	[2] 15	10+		90.16	5.64	2.12	1.08	.72	.36	2.00	87	93	.93		3.04	3.73	1.00	
Maximum	21	20+		95.34	12.29	5.84	1.58	1.06	.77	3.87	108	149	1.37		4.43	4.66	1.27	
Minimum	9	7		81.94	1.21	.26	.84	.60	.23	1.05	72	61	.52		2.17	3.01	.76	

[1] Undetermined.

[2] Average of 5 determinations.

TABLE X.—*Results of physical and chemical examination of maple-sugar samples*—Continued.

MAINE.

Serial number and county or district.	Physical properties.			Chemical analysis.										Tannin reaction.	Lead number.		Malic acid value.	Serial number.
	Color.		Taste.	Sucrose (Clerget).	Invert sugar.	Undetermined.	Total ash.	Soluble ash.	Insoluble ash.	Soluble ash. / Insoluble ash.	Alkalinity.				Winton.	Ross.		
	Sugar.	Sirup.									Soluble ash.	Insoluble ash.	Soluble ash. / Insoluble ash.					
				Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.		Cc.	Cc.						
Franklin-□:																		
6701	16	11	Good	96.20	1.85	0.99	0.96	0.62	0.34	1.82	80	80	1.00	None	2.38	3.64	0.99	6701
6702	18	11	...do	95.84	1.74	1.52	.90	.63	.27	2.33	79	79	1.00	...do	2.45	3.65	.97	6702
Oxford-□:																		
6700	12	10	Fair	87.00	10.93	1.11	.96	.65	.31	2.10	67	88	.76	...do	2.81	3.75	.99	6700
7594	14	12	Good	97.39	1.72	.11	.78	.55	.23	2.39	71	31	2.29	...do	2.08	2.57	.65	7594
Average (4)	15	11		94.11	4.06	.93	.90	.61	.29	2.10	74	69	1.07		2.43	3.40	.82	
Maximum	18	12		97.39	10.93	1.52	.96	.65	.34	2.39	80	88	2.29		2.81	3.75	.99	
Minimum	12	10		87.00	1.72	.11	.78	.55	.23	1.82	67	31	.76		2.08	2.57	.65	

MARYLAND.

Serial number and county or district.	Sugar.	Sirup.	Taste.	Sucrose (Clerget).	Invert sugar.	Undetermined.	Total ash.	Soluble ash.	Insoluble ash.	Soluble ash. / Insoluble ash.	Alkalinity: Soluble ash.	Alkalinity: Insoluble ash.	Alkalinity: Soluble ash. / Insoluble ash.	Tannin reaction.	Lead number: Winton.	Lead number: Ross.	Malic acid value.	Serial number.
Garrett□:																		
7506	12	11	Fair	94.23	3.72	1.13	0.92	0.63	0.29	2.17	83	70	1.19	None	3.23	3.58	0.90	7506
7507	13	12	...do	94.70	2.20	2.18	.92	.60	.32	1.88	78	83	.94	...do	2.55	3.02	.95	7507
7508	14	12+	...do	94.73	3.06	1.08	1.13	.77	.36	2.14	87	105	.83	Slight	3.21	3.37	1.07	7508
7510	16	7	Good	96.92	1.03	1.19	.86	.61	.25	2.44	69	56	1.23	None	2.15	2.47	.72	7510
7511	16	13	...do	96.04	1.31	1.84	.81	.44	.37	1.19	58	81	.71	...do	2.42	2.58	.78	7511
7512	15	13	...do	94.45	2.52	2.25	.78	.55	.23	2.39	57	64	.89	...do	2.14	2.32	.62	7512
7513	13	12	...do	95.81	1.96	1.26	.97	.70	.27	2.59	75	63	1.19	...do	2.47	2.98	.75	7513
7514	14	8	...do	97.49	1.28	.41	.82	.63	.29	2.18	65	68	.95	...do	2.42	2.68	.79	7514
7516	17	9	...do	96.56	.97	1.56	.91	.50	.41	1.22	61	91	.67	...do	2.79	3.06	.94	7516
7518	18	11	Fair	97.90	.65	.65	1.80	.51	.29	1.76	61	73	.83	...do	2.13	3.05	.76	7518
8413	18	13	...do	94.34	2.11	2.44	1.11	.77	.34	2.26	95	89	1.06	...do	3.19	3.78	1.08	8413
Average (11)	15	11		95.38	1.89	1.82	.91	.60	.31	1.94	71	77	.92		2.61	2.99	.85	
Maximum	18	13		97.90	3.72	2.44	1.13	.77	.41	2.59	95	105	1.23		3.23	3.78	1.08	
Minimum	12	7		94.23	.65	.41	.78	.44	.23	1.19	57	56	.67		2.13	2.32	.62	

MASSACHUSETTS.

Berkshire-□:																		
6597	13	11	Good	97.02	2.02	0.00	0.99	0.61	0.28	2.17	78	79	0.98	Slight	2.92	3.46	0.99	6597
6598	13	8	...do	83.54	14.54	1.05	.87	.62	.25	2.48	67	67	1.00	None	2.31	3.26	.87	6598
Franklin-□:																		
6621	15	8	Fair	94.09	4.59	.29	1.03	.69	.34	2.03	83	83	1.00	Slight	3.29	3.71	1.10	6621
6623	13	8	...do	92.85	5.54	.67	.94	.69	.25	2.76	87	68	1.28	...do	3.05	3.42	1.00	6623
6624	12	10	...do	86.74	11.96	.32	.98	.72	.26	2.77	84	72	1.16	...do	2.86	3.54	.95	6624
6626	12	11	...do	87.38	11.22	.48	.92	.69	.23	3.00	84	62	1.35	...do	2.47	3.63	.88	6626
7564	15	8	Good	97.56	.73	.69	1.02	.79	.23	3.43	90	62	1.45	None	2.70	3.49	.93	7564
7565	13	12	...do	98.02	.79	.19	1.00	.73	.27	2.70	92	68	1.35	...do	2.17	3.25	.76	7565
7566	15	9	Fair	98.13	.86	.09	.92	.69	.23	3.00	80	62	1.29	...do	2.41	2.70	.85	7566
7567	19	7	...do	98.62	.27	.12	.99	.75	.24	3.12	73	66	1.10	...do	2.57	3.12	.90	7567
7568	17	8	...do	97.12	1.00	.89	.99	.64	.25	2.56	80	64	1.25	...do	2.44	3.08	.89	7568
Hampden □:																		
6508	13	8	...do	93.34	5.71	.03	.92	.69	.23	3.00	78	61	1.28	...do	2.36	3.17	1.02	6508
6509	13	9	...do	94.89	3.79	.23	1.09	.78	.31	2.51	89	67	1.33	...do	2.81	3.33	1.00	6509
6510	13	8	...do	85.16	13.24	.58	1.02	.76	.26	2.92	82	70	1.17	...do	3.01	3.77	.98	6510
Average (14)	14	9	....	93.17	5.44	.41	.98	.72	.26	2.77	82	68	1.21	....	2.67	3.35	.99	....
Maximum	19	12	....	98.62	14.54	1.05	1.09	.79	.34	3.43	92	83	1.45	....	3.29	3.77	1.10	....
Minimum	12	7	....	83.54	.27	....	.87	.61	.23	2.03	67	61	.98	....	2.17	2.70	.76	....

MICHIGAN.

Barry □:																		
8358	14	10+	Fair	93.86	1.79	3.52	0.83	0.60	0.23	2.61	74	63	1.17	None	2.29	3.02	0.64	8358
8359	12	12	...do	95.26	2.48	1.41	.85	.62	.23	2.69	82	58	1.41	Slight	2.35	3.08	.68	8359
Branch □:																		
8345	12	12	Poor	90.87	4.75	3.47	.91	.55	.36	1.53	65	91	.71	None	2.76	3.33	.91	8345
8355	14	10	Fair	91.86	3.85	3.25	.94	.63	.31	2.03	86	71	1.21	...do	2.42	3.44	.97	8355
8356	12	11	...do	91.98	5.06	2.17	.79	.55	.24	2.29	66	60	1.10	Slight	1.93	3.28	.62	8356
8357	15	9	Good	95.53	.41	3.11	.95	.68	.27	2.52	81	75	1.08	None	2.18	2.83	.85	8357
Ingham □:																		
6457	14	12	Poor	93.13	5.10	.73	1.04	.78	.26	3.00	75	90	.84	Slight	3.13	3.66	.93	6457
6458	13	10	Fair	89.78	8.00	1.27	.95	.67	.28	2.39	74	83	.89	...do	2.98	3.72	.89	6458
6459	13	9	Good	82.99	15.17	.99	.85	.58	.27	2.15	63	82	.77	...do	2.78	3.82	.88	6459
7524	14	9	...do	97.12	1.08	.98	.82	.46	.36	1.28	62	90	.69	None	2.48	3.35	.84	7524
7526	11	15	Fair	92.04	4.54	2.50	.92	.61	.31	1.97	72	87	.83	...do	2.52	3.42	.81	7526
7525	12	11	Good	97.05	.89	1.09	.97	.74	.23	3.22	86	62	1.38	...do	2.46	3.11	.80	7525
Ionia □:																		
6476	10	15	Burned	82.38	14.34	2.18	1.10	.67	.43	1.56	68	116	.59	Trace	3.28	4.03	.96	6476
8360	15	10	Fair	91.64	6.38	1.06	.92	.69	.23	3.00	83	67	1.22	None	2.60	3.43	.84	8360
8361	14	10	...do	94.75	2.23	2.18	.84	.62	.22	2.82	77	56	1.38	...do	2.15	3.14	.70	8361

TABLE X.—*Results of physical and chemical examination of maple-sugar samples*—Continued.

MICHIGAN—Continued.

Serial number and county or district.	Physical properties. Color. Sugar.	Physical properties. Color. Sirup.	Physical properties. Taste.	Chemical analysis. Sucrose (Clerget).	Invert sugar.	Undetermined.	Total ash.	Soluble ash.	Insoluble ash.	Soluble ash. / Insoluble ash.	Alkalinity. Soluble ash.	Alkalinity. Insoluble ash.	Alkalinity. Soluble ash. / Insoluble ash.	Tannin reaction.	Lead number. Winton.	Lead number. Ross.	Malic acid value.	Serial number.
Kent -□:				*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*		*Cc.*	*Cc.*						
6499	13	10	Fair	95.05	3.57	.46	.92	.61	.31	1.97	75	92	0.81	Slight	3.11	3.72	1.03	6499
8362	13	13	do	91.45	4.14	3.45	.96	.61	.35	1.74	70	95	.73	do	2.72	3.59	.90	8362
8364	12	13+	do	90.00	6.88	2.31	.81	.58	.23	2.52	72	61	1.18	do	2.18	3.03	.69	8364
8365	13	13	do	90.32	6.85	2.06	.77	.54	.23	2.35	65	57	1.14	do	1.96	2.92	.61	8365
8366	13	10+	do	95.56	2.33	1.18	.93	.70	.23	3.04	74	56	1.32	None	1.91	2.54	.60	8366
Lenawee □:																		
8354	14	9	do	94.80	7.94	2.49	.77	.54	.23	2.35	72	60	1.20	do	2.13	2.89	1.15	8354
Ottawa -□:																		
6489	12	10	do	85.45	10.69	2.83	1.03	.67	.36	1.87	74	102	.72	Slight	3.29	4.18	1.08	6489
8363		11+	do	93.26	4.08	1.89	.79	.53	.26	2.03	67	83	.81	do	2.42	3.13	.78	8363
Average (23)	[1] 13	11		92.00	4.63	2.47	.90	.62	.28	2.21	73	76	.96		2.52	3.33	.83	
Maximum	15	15		97.12	15.17	3.52	1.10	.78	.43	3.22	86	116	1.41		3.29	4.18	1.15	
Minimum	11	9		82.38	.41	.46	.77	.46	.22	1.28	62	56	.59		1.91	2.54	.60	

NEW HAMPSHIRE.

Serial number and county or district.	Sugar.	Sirup.	Taste.	Sucrose (Clerget).	Invert sugar.	Undetermined.	Total ash.	Soluble ash.	Insoluble ash.	Soluble ash. / Insoluble ash.	Alkalinity. Soluble ash.	Alkalinity. Insoluble ash.	Alkalinity. Soluble ash. / Insoluble ash.	Tannin reaction.	Winton.	Ross.	Malic acid value.	Serial number.
Cheshire □:																		
7581	14	9	Good	97.43	1.10	0.48	0.99	0.71	0.28	2.52	80	77	1.04	None	2.55	3.35	0.90	7581
7582	13	11	Poor	91.96	6.15	.91	.98	.70	.28	2.50	78	81	.97	Slight	2.42	3.36	.78	7582
8432	16	10	Fair	94.40	1.36	3.43	.81	.56	.25	2.24	73	61	1.19	None	1.97	2.76	.75	8432
8433	16	9	do	94.92	1.69	2.55	.84	.59	.25	2.36	76	58	1.31	do	2.17	3.00	.76	8433
8434	13	13	do	93.47	2.10	3.63	.80	.47	.33	1.42	64	83	.77	do	1.91	2.65	.72	8434
Grafton -□:																		
6678	13	9	do	79.69	16.77	2.70	.84	.48	.36	1.33	66	81	.81	do	2.43	4.32	.90	6678
6679	12	9	do	69.81	27.21	2.12	.86	.48	.38	1.27	69	91	.75	do	2.81	3.78	1.02	6679
6684	13	9	do	90.83	7.43	.86	.88	.52	.36	1.45	75	88	.85	do	2.44	3.49	.96	6684
6685	11	13	Burned	91.57	6.08	1.41	.94	.51	.43	1.18	63	97	.65	Trace	2.49	3.82	1.05	6685

Hillsborough □:																		
6662	13	11	Good	93.13	4.29	1.65	.93	.67	.26	2.57	83	62	1.34	None	2.41	3.35	.93	6662
6663	13	11	...do	92.65	5.70	.52	1.13	.74	.39	1.89	87	104	.83	Slight	3.48	4.27	1.21	6663
Sullivan □:																		
6677	14	8	Fair	84.65	12.69	1.73	.93	.64	.29	2.21	81	81	1.00	None	2.97	3.94	1.09	6677
Average (12)	13+	10	....	89.54	7.71	1.84	.91	.59	.32	1.84	75	80	.94	....	2.50	3.50	.92	....
Maximum	16	13	....	97.43	27.21	3.63	1.13	.74	.43	2.57	87	104	1.34	....	3.48	4.32	1.21	....
Minimum	11	8	....	69.81	1.10	.48	.80	.48	.25	1.18	63	61	.65	....	1.91	2.65	.72	....

NEW YORK.

Allegany □:																		
6545	14	8	Fair	84.46	11.70	3.00	0.84	0.48	0.36	1.33	60	66	0.90	None	2.17	3.22	0.75	6545
6546	16	12	...do	94.70	3.88	.45	.97	.64	.33	1.94	58	79	.73	Slight	2.71	3.28	.97	6546
7546	13	10	Good	97.20	1.15	.75	.90	.67	.23	2.91	86	55	1.56	None	2.45	3.46	.86	7546
7547	11	12	...do	96.08	2.03	.04	.85	.61	.24	2.54	79	57	1.39	...do	2.37	3.05	.77	7547
7548	16	7	...do	97.75	.34	1.06	.85	.61	.24	2.54	81	60	1.35	...do	2.52	3.01	.88	7548
7549	15	8	...do	97.54	.51	1.09	.86	.63	.23	2.74	83	53	1.56	...do	2.45	2.98	.83	7549
7550	14	10	...do	96.20	2.13	.76	.91	.67	.24	2.79	83	55	1.51	...do	2.67	3.11	.82	7550
7551	13	11	...do	96.08	1.50	1.54	.88	.63	.25	2.52	87	65	1.34	...do	2.61	3.29	.80	7551
7552	15	8	...do	98.03	.29	.68	1.00	.73	.27	2.70	88	54	1.63	...do	2.36	3.03	.80	7552
8324	18	8	...do	95.50	1.25	2.38	.87	.55	.32	1.72	71	72	.98	...do	2.18	2.75	.84	8324
8325	18	9	...do	95.06	1.14	3.01	.79	.50	.29	1.73	67	73	.92	...do	2.05	2.74	.82	8325
Cattaraugus □:																		
6547	12	10	...do	97.88	1.07	.10	.95	.69	.26	2.65	58	75	.77	...do	2.45	2.77	.95	6547
6601	12	11	Fair	97.12	1.78	.22	.88	.61	.27	2.26	65	78	.88	Slight	2.41	2.79	.80	6601
6602	13	8	Good	97.07	1.47	.61	.85	.60	.25	2.40	68	74	.92	None	2.18	2.72	.96	6602
Chautauqua □:																		
6548	13	9	Fair	90.47	7.72	.88	.93	.61	.32	1.91	53	82	.64	...do	2.61	3.18	1.04	6548
6549	8	13	...do	84.48	12.70	1.84	.98	.58	.40	1.45	52	91	.57	Slight	2.74	3.37	1.05	6549
6550	11	10+	Good	96.24	2.64	.10	1.02	.70	.32	2.18	83	80	1.04	...do	2.73	3.22	.99	6550
6552	13	8	...do	97.70	1.54	.04	.80	.55	.25	2.20	69	61	1.13	None	2.78	3.11	.73	6552
6553	13	8	...do	95.80	2.80	.39	1.01	.75	.26	2.89	77	77	1.00	...do	2.46	3.12	.92	6553
7553	16	10	...do	98.02	.71	.49	.78	.54	.24	2.27	69	60	1.15	...do	2.14	2.87	.71	7553
7554	14	8	...do	98.00	.31	.90	.79	.56	.23	2.43	78	70	1.56	...do	2.36	2.57	.73	7554
7555	12	11	...do	96.16	1.96	1.02	.86	.55	.31	1.77	64	70	.91	...do	2.26	2.77	.74	7555
7556	12	14	...do	96.42	.84	1.78	.96	.49	.47	1.04	66	96	.68	...do	2.20	3.00	.79	7556
7557	13	9	...do	97.80	.96	.16	1.08	.81	.27	3.00	73	61	1.19	...do	2.64	2.98	.73	7557
8328	....	7	...do	96.20	1.01	2.01	.78	.53	.25	2.12	75	70	1.07	...do	2.23	....	.89	8328
Chenango □:																		
6486	14	8	Poor	84.89	13.20	.99	.92	.67	.25	2.68	77	74	1.04	...do	2.74	3.58	.94	6486
6487	13	9+	Fair	94.81	3.97	.23	.99	.67	.32	2.09	76	83	.92	...do	2.86	3.42	1.05	6487
Cortland □:																		
6472	14	9	...do	97.34	1.56	.27	.83	.60	.23	2.61	79	58	1.36	...do	2.26	2.73	.74	6472
6479	12	9	...do	93.12	5.34	.57	.97	.62	.35	1.78	74	86	.86	Slight	2.97	3.53	1.05	6479
6485	11	11	Good	97.53	1.00	.44	1.03	.75	.28	2.69	85	74	1.15	...do	2.69	3.17	.94	6485
6554	13	10	Fair	96.46	2.07	.39	1.08	.84	.24	3.50	79	71	1.11	...do	2.67	3.11	1.02	6554

[1] Average of 22 determinations.

TABLE X.—*Results of physical and chemical examination of maple-sugar samples*—Continued.

NEW YORK—Continued.

Serial number and county or district.	Physical properties. Color. Sugar.	Physical properties. Color. Sirup.	Physical properties. Taste.	Chemical analysis. Sucrose (Clerget).	Invert sugar.	Undetermined.	Total ash.	Soluble ash.	Insoluble ash.	Soluble ash / Insoluble ash.	Alkalinity. Soluble ash.	Alkalinity. Insoluble ash.	Alkalinity. Soluble ash / Insoluble ash.	Tannin reaction.	Lead number. Winton.	Lead number. Ross.	Malic acid value.	Serial number.
Courtland—Continued.				*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*		*Cc.*	*Cc*						
6555	15	7	Fair	94.24	4.06	0.91	0.79	0.53	0.26	2.03	52	68	0.77	Slight	2.21	2.88	0.83	6555
7559	15	9	do	97.61	1.02	.58	.79	.51	.28	1.82	49	58	.85	do	1.86	2.89	.60	7559
7560	12	9	Good	96.64	.77	1.81	.78	.51	.27	1.89	64	59	1.08	do	1.87	2.31	.67	7560
7561	12	11	Fair	97.48	.83	.88	.81	.58	23	2.52	76	50	1.52	do	2.37	2.45	.70	7561
7562	17	7	Good	98.01	.90	.11	.98	.75	.23	3.21	68	57	1.19	do	2.14	2.65	.76	7562
Delaware □:																		
6636	17	7	Fair	97.46	1.22	.38	.94	.66	.28	2.36	73	93	.78	do	2.38	3.48	1.02	6636
6638	14	8	do	97.63	.92	.53	.92	.68	.24	2.83	71	85	.83	do	2.11	3.28	.98	6638
6639	13	13	Good	98.14	1.14	.19	.91	.65	.26	2.51	71	86	.82	Trace	2.34	3.23	.95	6639
6640	13	13+	Burned	94.08	3.44	1.16	1.32	1.06	.26	4.07	123	88	1.39	do	3.64	3.87	1.21	6640
6641	12	13	do	95.20	2.76	1.13	.91	.63	.28	2.25	71	92	.77	None	2.60	3.48	1.00	6641
6643	13	11	Fair	96.85	1.81	.42	.92	.63	.29	2.20	70	92	.76	Trace	2.44	3.26	.98	6643
6664	12	11	do	94.00	4.79	.41	.80	.51	.29	1.76	58	68	.85	do	1.89	2.67	.71	6664
7583	13	10	Good	98.22	.97	.05	.86	.49	.37	1.32	66	85	.77	None	2.23	2.74	.88	7583
7584	14	10	do	98.16	1.05	+.14	.93	.51	.42	1.21	66	104	.63	do	2.75	3.55	.97	7584
7585	14	8	do	98.05	.48	.52	.95	.56	.39	1.44	66	88	.75	do	2.28	2.97	.89	7585
Lewis ⌂:																		
6603	12	16	Fair	94.56	3.84	.60	1.00	.58	.42	1.38	56	106	.52	Good	(1)	....	(1)	6603
6604	16	10	do	98.09	.55	.48	.88	.55	.33	1.67	61	86	.71	Slight	2.35	2.80	.91	6604
6607	13	12	Good	98.52	....	.60	.88	.49	.39	1.26	62	80	.77	do	2.07	2.47	.80	6607
6608	16	11	do	98.07	.50	.56	.87	.49	.48	1.29	58	93	.62	do	2.10	2.50	.84	6608
7575	14	12	do	98.07	.98	.03	.92	.69	.23	3.00	72	64	1.13	None	2.06	3.23	.69	7575
7576	16	10	do	98.24	.49	.26	1.01	.77	.24	3.21	80	52	1.54	do	2.10	2.89	.76	7576
7577	15	8	do	98.28	1.43	+.95	1.24	.64	.60	1.07	69	60	1.15	do	2.15	2.88	.74	7577
7578	16	8	do	96.87	1.89	.29	.95	.67	.28	2.39	74	71	1.04	do	2.61	3.04	.91	7578
7579	13	9	do	96.57	2 26	.09	1.08	.78	.30	2.60	82	76	1.08	do	3.04	3.43	.99	7579
7580	14	10	do	96.87	1.79	.34	1.00	.70	.30	2.34	85	85	1.00	do	2.59	3.96	.91	7580
Average (56)	[2] 14	10	....	96.04	2.33	.71	.92	.62	.30	2.07	72	73	.99	....	2.42	[2] 3.05	.87	....
Maximum	18	16	....	98.52	13.20	3.01	1.32	1.06	.60	4.07	123	106	1.63	....	3.64	3.96	1.21	....
Minimum	8	7	....	84.46	.29	.04	.78	.48	.23	1.04	49	50	.52	....	1.86	2.31	.60	....

OHIO.

Allen □:																		
7572	12	9	Good	96.20	1.84	1.04	0.92	0.69	0.23	3.00	78	61	1.28	None	2.41	3.00	0.78	7572
Champaign □:																		
6313	14	9	Fair	85.51	10.51	3.01	.97	.65	.32	2.03	86	92	.93	...do	3.53	3.62	1.14	6313
6321	12	8	...do	98.38	.68	.05	.99	.72	.27	2.66	62	56	1.11	...do	2.17	2.54	.74	6321
Cuyahoga □:																		
6966	14	8	Good	87.95	9.07	1.99	.99	.68	.31	2.19	72	79	.91	...do	2.77	3.74	1.07	6966
6967	12	9	...do	84.84	13.10	1.19	.87	.64	.23	.78	71	81	.87	...do	2.50	3.48	.88	6967
Geauga □:																		
6370	14	12	Fair	91.49	5.60	1.93	.98	.67	.31	2.16	73	78	.93	...do	3.10	3.73	1.03	6370
6373	16	8	...do	83.34	14.08	1.80	.78	.42	.36	1.17	50	76	.66	...do	2.16	2.22	.74	6373
6374	13	7	...do	83.31	10.93	4.94	.82	.43	.39	1.10	49	86	.57	...do	2.23	2.25	.83	6374
6378	11	10	...do	84.85	11.90	2.33	.92	.47	.45	1.03	63	96	.65	...do	2.60	2.72	.92	6378
6968	14	13	Poor	80.46	17.33	1.22	.99	.61	.38	1.61	59	104	.56	...do	2.94	3.95	1.08	6968
6969	13	12	Fair	78.94	18.09	2.09	.84	.61	.23	2.73	58	67	.86	...do	2.66	3.63	.86	6969
8347	16	9	Fair	95.88	1.42	1.87	.83	.60	.23	2.60	70	61	1.15	...do	2.06	2.85	.71	8347
8348	13	9	Good	94.13	2.11	2.96	.80	.56	.24	2.33	65	71	.81	...do	2.13	2.96	.67	8348
8349	18	7+	...do	96.00	.68	2.55	.77	.55	.22	2.50	73	43	1.70	...do	1.86	2.58	.92	8349
8351	16	7	...do	96.53	.33	2.38	.76	.53	.23	2.30	76	55	1.38	...do	1.85	2.45	.78	8351
8447	....	6	Fair	95.62	.21	3.28	.89	.56	.33	1.70	69	90	.77	...do	2.50	3.13	1.01	8447
8448	17	8	...do	94.64	.98	3.43	.95	.62	.33	1.88	77	86	.89	...do	2.61	3.31	1.00	8448
8449	14	11	...do	93.61	1.56	3.78	1.05	.62	.43	1.44	79	102	.77	...do	2.93	3.86	1.07	8449
8450	....	7	Good	95.04	.26	3.80	.90	.58	.32	1.81	67	83	.80	...do	2.28	2.95	.61	8450
Logan □:																		
6314	14	8	Fair	95.06	2.64	1.37	.93	.64	.29	2.21	79	82	.96	...do	3.10	3.35	1.01	6314
6315	12	12	...do	93.50	2.74	2.59	1.17	.82	.35	2.34	98	105	.93	Trace	3.61	3.57	1.14	6315
6316	8	16	...do	94.45	1.77	2.66	1.12	.78	.34	2.29	91	109	.83	...do	3.45	3.56	1.11	6316
6317	11	12	...do	95.25	1.94	1.89	.92	.58	.34	1.71	75	92	.81	...do	3.07	3.36	1.02	6317
6318	13	10	Poor	93.25	3.04	2.64	1.07	.68	.39	1.74	83	107	.79	None	3.47	3.32	....	6318
6319	16	12	Fair	93.26	1.90	2.73	1.11	.80	.31	2.58	97	91	1.06	...do	3.62	3.95	1.16	6319
6320	14	12	...do	88.22	8.78	1.77	1.23	.86	.37	2.32	93	101	.92	Trace	4.24	4.67	1.31	6320
Medina □:																		
7570	13	11	Good	96.00	1.74	1.33	.93	.59	.34	1.73	70	71	.98	None	2.37	3.21	.83	7570
7571	14	10	...do	95.54	2.76	.87	.83	.56	.27	2.07	69	59	1.17	...do	2.24	3.10	.77	7571
Morrow □:																		
7573	12	11	Fair	95.88	1.90	1.33	.89	.64	.25	2.56	78	65	1.20	...do	2.04	2.75	.76	7573
7574	9	20	...do	57.04	30.02	5.72	1.42	1.04	.38	2.74	97	80	1.21	Trace	3.98	4.27	.74	7574
Trumbull □:																		
6718	14	8	Poor	75.12	22.16	1.82	.90	.67	.23	2.91	75	70	1.07	None	2.67	3.88	.93	6718
Average (31)	[3] 13	10	....	89.98	6.52	2.55	.95	.64	.31	2.06	74	81	.91	....	2.74	3.29	.92	....
Maximum	18	20	....	98.38	30.02	5.72	1.23	1.04	.45	3.00	98	109	1.70	....	4.24	4.67	1.16	....
Minimum	8	7	....	57.04	.21	.05	.76	.42	.22	1.03	49	43	.56	....	1.85	2.22	.61	....

[1] Undetermined. [2] Average of 55 determinations. [3] Average of 29 determinations.

TABLE X.—*Results of physical and chemical examination of maple-sugar samples*—Continued.

PENNSYLVANIA.

Serial number and county or district.	Physical properties. Color. Sugar.	Physical properties. Color. Sirup.	Physical properties. Taste.	Chemical analysis. Sucrose (Clerget).	Chemical analysis. Invert sugar.	Chemical analysis. Undetermined.	Chemical analysis. Total ash.	Chemical analysis. Soluble ash.	Chemical analysis. Insoluble ash.	Chemical analysis. Soluble ash / Insoluble ash.	Chemical analysis. Alkalinity. Soluble ash.	Chemical analysis. Alkalinity. Insoluble ash.	Chemical analysis. Alkalinity. Soluble ash / Insoluble ash.	Tannin reaction.	Lead number. Winton.	Lead number. Ross.	Malic acid value.	Serial number.
Bradford□:				*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*		*Cc.*	*Cc.*						
6873	14	16	Good	93.60	4.16	1.01	1.23	0.69	0.54	1.28	68	135	0.50	Trace	3.90	4.23	1.23	6873
6874	15	9	Fair	91.96	5.89	1.01	1.14	.75	.39	1.92	92	89	1.03	None	2.16	4.53	1.24	6874
6875	13	9	Good	97.97	.82	.28	.93	.66	.27	2.45	73	115	.63	...do	2.75	2.90	.82	6875
6876	13	10	...do	89.08	10.30	.16	.78	.52	.26	2.00	52	55	.94	...do	1.91	2.66	.69	6876
6877	12	12		87.92	7.50	3.60	.98	.72	.26	2.77	69	90	.77		3.04	3.56	.90	6877
6884	16	8		96.89	.78	1.30	1.03	.71	.32	2.22	68	98	.69		2.77	2.86	.86	6884
Lancaster□:																		
6864	16	16	Fair	93.40	5.16	.19	1.25	1.00	.25	4.00	140	75	1.86	None	3.68	3.71	1.14	6864
Lebanon□:																		
8343	(1)	9	Smoky	95.23	.71	3.19	.87	.60	.27	2.23	75	74	1.01	...do	2.28	2.75	.87	8343
8344	15	10	Fair	96.00	.98	2.24	.78	.52	.21	2.47	57	54	1.05	...do	1.85	2.20	.59	8344
Somerset□:																		
6865	12	13	...do	95.71	1.54	1.72	1.03	.71	.32	2.22	89	82	1.08	Slight	3.74	4.48	1.06	6865
6866	15	13	...do	95.67	2.18	1.20	.95	.67	.28	2.39	74	77	.96	...do	3.00	3.68	.95	6866
6867	20	11	Good	97.04	1.45	.41	1.10	.74	.36	2.06	62	127	.49	None	3.48	3.64	1.16	6867
6868	19	13	...do	94.20	4.38	.37	1.05	.66	.39	1.69	80	145	.55	Trace	3.05	3.89	.97	6868
6869	11	16	Fair	94.68	4.40	.20	1.12	.76	.36	2.11	81	89	.91	...do	3.96	4.35	1.09	6869
6870	13	16	...do	94.84	3.76	.17	1.23	.87	.36	2.41	106	94	1.14	...do	4.49	4.92	1.23	6870
6872	13	20+	Poor	91.09	6.76	.89	1.26	.66	.60	1.10	60	138	.43	...do	3.69	3.74	1.07	6872
6878	8	17	...do	91.21	7.09	.59	1.11	.65	.46	1.41	77	96	.80	...do	3.88	4.39	1.14	6878
6879	17	17	...do	93.12	5.70	.04	1.14	.72	.42	1.71	74	117	.63	...do	3.70	3.87	1.01	6879
6880	13	13+	Fair	93.07	4.91	.82	1.20	.68	.52	1.30	78	113	.69	...do	4.24	4.76	1.31	6880
6881	10	16	Burned	87.10	10.70	1.06	1.14	.67	.47	1.42	70	95	.74	...do	3.82	4.55	1.15	6881
6882	20	15	Fair	95.24	2.49	1.18	1.09	.73	.36	2.03	72	129	.56	...do	3.22	3.30	.90	6882
7515	17	12	...do	96.80	1.35	.88	.97	.68	.29	2.34	73	64	1.14	None	2.38	2.73	.73	7515
7517	15	15	Good	97.10	.54	1.25	1.11	.68	.43	1.58	83	88	.94	...do	2.85	2.98	1.00	7517
Warren□:																		
6430	14	8	Fair	96.81	1.77	.59	.83	.64	.29	2.20	64	75	.85	...do	2.16	2.45	.81	6430
6431	13	8	...do	92.90	6.32	.07	.85	.53	.32	1.66	70	79	.88	...do	2.44	2.79	.88	6431
6432	11	9	Poor	57.37	37.30	4.15	1.18	.83	.35	2.37	99	89	1.11	...do	3.75	4.29	1.15	6432
6433	13	9	Fair	87.90	10.50	.81	.79	.47	.32	1.47	58	73	.80	...do	2.16	2.75	.85	6433
6434	12	9	...do	85.03	13.84	.34	.79	.44	.35	1.26	45	81	.56	...do	2.10	2.73	.77	6434
6435	13	11	...do	84.71	14.50	.02	.81	.51	.30	1.70	66	75	.88	...do	2.24	2.52	.78	6435

6436	12	11	...do...	87.74	10.38	.82	.96	.70	.26	2.69	72	79	.91	...do...	2.65	3.25	.92	6436
6437	11	12	Poor...	96.79	2.12	.28	.81	.56	.25	2.24	59	65	.90	Slight...	2.19	2.69	.74	6437
6438	14	10	Fair...	95.49	2.91	.66	.94	.70	.24	2.91	70	71	.98	None...	2.22	3.64	.81	6438
Wayne □:																		
8329	(1)	10	Good...	93.83	3.68	1.71	.78	.50	.28	1.78	68	69	.98	...do...	2.19	2.83	.75	8329
8330	(1)	9	...do...	95.70	1.03	2.46	.81	.59	.22	2.68	83	48	1.75	...do...	2.01	2.49	.77	8330
8332	(1)	7	...do...	96.80	.93	1.46	.81	.57	.24	2.33	77	63	1.22	...do...	2.26	2.71	.84	8332
8333	19	7+	Smoky..	96.66	.88	1.62	.84	.61	.23	2.65	84	63	1.33	...do...	2.36	2.78	.82	8333
8334	(1)	7	...do...	96.64	.45	2.01	.90	.67	.23	2.91	73	49	1.48	...do...	2.00	2.41	.77	8334
8335	(1)	9	Poor...	95.10	.84	2.12	.94	.54	.40	1.35	71	87	.82	...do...	2.84	3.26	1.05	8335
8336	(1)	7+	Fair...	95.43	1.20	2.30	1.07	.61	.46	1.32	80	108	.74	...do...	3.13	4.07	1.16	8336
8337	(1)	8	Good...	97.30	.53	1.37	.80	.57	.23	2.48	72	50	1.44	...do...	1.87	2.49	.62	8337
8338	16	9+	Fair...	93.98	3.08	2.16	.78	.47	.31	1.51	62	77	.80	...do...	2.50	3.02	.89	8338
8342	(1)	10	...do...	94.70	1.91	2.70	.79	.56	.23	2.43	76	51	1.49	...do...	1.86	2.59	.63	8342
8339	16	10+	...do...	93.92	2.99	2.27	.82	.58	.24	2.41	71	63	1.12	...do...	2.40	2.95	.83	8339
Average (43)	[2] 14	11	....	92.92	4.92	1.19	.97	.64	.33	1.94	74	85	.87	....	2.84	3.34	.93	....
Maximum	20	20+	....	97.97	37.30	4.15	1.26	1.00	.60	4.00	140	145	1.86	....	4.49	4.92	1.31	....
Minimum	8	7	....	57.37	.45	.02	.78	.44	.21	1.10	45	48	.43	....	1.85	2.20	.59	....

VERMONT.

Addison □:																		
6703	12	8+	Fair...	76.78	19.61	2.79	0.82	0.53	0.29	1.83	68	65	1.05	None...	1.93	3.22	0.85	6703
6704	11	10+	...do...	82.19	13.35	3.57	.89	.50	.39	1.28	65	90	.72	...do...	2.55	3.83	1.01	6704
Bennington □:																		
6617	9	13	Good...	94.54	4.03	.65	.78	.44	.34	1.29	60	38	1.59	Trace...	1.88	2.35	.62	6617
Chittenden □:																		
6710	12	10+	...do...	89.95	6.13	3.08	.84	.60	.24	2.50	73	59	1.23	...do...	2.04	3.20	.78	6710
6711	8	20	Strong..	89.55	5.32	3.91	1.22	.67	.55	1.22	59	113	.52	Strong..	2.92	3.72	.94	6711
6712	10	12	Fair...	81.60	14.06	3.56	.78	.49	.29	1.69	93	93	1.00	Slight...	2.27	3.17	.87	6712
Franklin □:																		
6743	12	13	...do...	89.67	8.10	1.41	.82	.58	.24	2.42	64	66	.97	Trace...	2.28	3.13	.75	6743
6744	11	15	...do...	92.52	4.39	2.21	.88	.54	.34	1.58	65	93	.70	...do...	3.05	3.27	.87	6744
6745	15	8	...do...	86.79	10.34	2.04	83	.53	.30	1.77	67	81	.82	None...	2.46	3.74	.99	6745
6746	12	11	...do...	85.00	11.23	2.93	.84	.58	.26	2.23	71	72	.98	Slight...	2.62	3.09	.83	6746
6747	12	11	Poor...	90.70	5.18	3.18	.94	.63	.31	2.03	77	80	.96	...do...	2.30	3.05	.89	6747
Lamoille □:																		
6748	10	13	Fair...	90.88	6.15	2.10	.87	.45	.42	1.07	69	97	.71	...do...	2.54	3.28	.92	6748
6749	11	11	Good...	92.69	4.90	1.63	.78	.38	.40	.95	61	86	.71	None...	2.14	2.94	.83	6749
6750	13	10	...do...	90.52	7.08	1.56	.84	.55	.29	1.90	70	79	.89	...do...	2.45	3.41	.88	6750
6752	12	10	...do...	91.40	6.29	1.53	.78	.47	.31	1.52	61	76	.80	...do...	2.05	2.97	.78	6752
6753	12	12	Poor...	89.18	7.67	2.14	1.01	.47	.54	.87	65	125	.52	...do...	3.37	4.16	1.22	6753
6754	14	10	Fair...	85.54	11.35	2.19	.92	.40	.52	.77	58	113	.51	...do...	3.06	3.78	1.07	6754
6756	13	10	Good...	91.38	6.18	2.61	.83	.51	.32	1.59	68	80	.85	...do...	2.51	3.37	.88	6756
6757	13	10	Fair...	95.38	2.71	1.13	.78	.51	.27	1.89	70	67	1.04	...do...	2.03	2.79	.76	6757
6758	12	9	...do...	91.36	5.49	2.32	.83	.51	.32	1.59	71	77	.92	...do...	2.38	3.24	.88	6758
6760	12	10	...do...	75.39	18.53	5.12	.96	.58	.38	1.52	80	83	.96	...do...	3.49	3.84	1.01	6760

[1] Undetermined.

[2] Average of 34 determinations.

TABLE X.—*Results of physical and chemical examination of maple-sugar samples*—Continued.

VERMONT—Continued.

Serial number and county or district.	Physical properties. Color. Sugar.	Physical properties. Color. Sirup.	Physical properties. Taste.	Chemical analysis. Sucrose (Clerget).	Chemical analysis. Invert sugar.	Chemical analysis. Undetermined.	Chemical analysis. Total ash.	Chemical analysis. Soluble ash.	Chemical analysis. Insoluble ash.	Chemical analysis. Soluble ash. / Insoluble ash.	Alkalinity. Soluble ash.	Alkalinity. Insoluble ash.	Alkalinity. Soluble ash. / Insoluble ash.	Tannin reaction.	Lead number. Winton.	Lead number. Ross.	Malic acid value.	Serial number
				Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*		*Cc.*	*Cc.*						
Lamoille—Continued.																		
6761	11	11	Fair	88.06	9.33	1.83	0.78	0.47	0.31	1.52	58	78	0.74	Slight	2.63	3.11	0.81	6761
6762	10	16	Poor	88.84	9.46	.86	.84	.47	.37	1.27	55	93	.59	do	2.38	3.82	.90	6762
6763	13	10	Fair	87.67	9.57	1.88	.98	.64	.34	1.88	77	84	.91	do	3.40	3.80	1.00	6763
6764	14	8	do	86.50	7.15	5.51	.84	.52	.32	1.62	67	76	.88	None	2.87	3.34	.87	6764
6765	16	10	do	97.71	.66	.83	.80	.37	.43	.86	37	96	.38	do	2.21	2.59	.78	6765
6767	12	10	do	90.62	7.67	.73	.98	.64	.34	1.88	78	87	.89	do	3.45	3.90	1.02	6767
7613	15	8	Good	96.02	1.77	1.39	.82	.58	.24	2.42	62	58	1.07	do	2.20	2.67	.65	7613
7614	14	11	do	90.65	5.42	3.06	.87	.58	.29	2.00	71	65	1.09	do	2.20	2.79	.74	7614
7615	13	11	do	96.48	1.99	.60	.93	.69	.24	2.88	80	59	1.35	do	2.01	2.58	.67	7615
Orange □:																		
8462	(1)	14	Fair	94.28	.79	4.03	.90	.43	.47	.91	59	112	.52	Slight	1.90	2.51	.73	8462
8465	(1)	11	Poor	92.60	2.76	3.61	1.03	.39	.64	.61	62	144	.43	None	3.13	3.83	1.21	8465
Orleans □:																		
6783	11	11	Fair	83.14	13.72	2.19	.95	.65	.30	2.17	79	79	1.00	do	3.34	3.91	.95	6783
6784	13	10+	do	83.36	13.54	2.10	1.00	.44	.56	.78	46	123	.37	Slight	2.90	3.78	1.05	6784
6785	10	12	do	75.97	19.01	3.79	1.23	.56	.67	.83	71	106	.67	do	3.82	4.60	1.30	6785
6786	12	16	Strong	89.15	8.02	1.60	1.23	.64	.59	1.08	78	124	.63	do	3.78	4.53	1.17	6786
6787	11	9	Fair	73.58	22.62	2.84	.96	.56	.40	1.40	68	97	.70	do	3.22	4.07	1.09	6787
6788	11	13	Burned	85.26	11.02	2.62	1.10	.49	.61	.80	58	132	.44	do	3.58	3.58	1.18	6788
6789	15	11	Fair	83.05	12.71	3.18	1.06	.43	.63	.68	56	131	.43	do	3.38	4.10	1.17	6789
6791	11	9	Poor	71.85	23.22	4.05	.88	.53	.35	1.51	65	83	.78	None	2.85	3.71	.94	6791
6792	10	11	do	70.40	25.00	3.64	.96	.53	.43	1.23	62	112	.55	Slight	3.60	4.38	1.21	6792
6793	12	11	Fair	85.56	11.07	2.35	1.02	.52	.50	1.04	62	119	.52	None	3.69	4.28	1.19	6793
6794	12	11	do	81.38	13.80	3.80	1.02	.45	.57	.78	48	121	.40	Slight	3.21	3.88	1.10	6794
6797	9	20+	Poor	85.60	11.28	1.71	1.41	.60	.81	.74	66	166	.39	Strong	3.60	4.16	1.25	6797
6798	9	19	do	83.62	12.35	2.83	1.20	.56	.64	.88	64	109	.59	Slight	3.67	4.03	1.03	6798
6799	11	14	Fair	83.56	12.88	2.50	1.06	.55	.51	1.08	65	105	.62	do	4.06	4.63	1.20	6799
6800	11	20	Burned	74.53	23.85	.50	1.12	.64	.48	1.34	81	110	.73	None	3.59	4.10	1.10	6800
7612	13	10	Good	97.49	1.07	.53	.91	.61	.30	2.03	83	65	1.27	do	1.98	2.49	.67	7612
Rutland □:																		
6644	14	8	Fair	95.22	3.48	.50	.80	.54	.26	2.07	62	89	.70	do	2.25	3.20	.91	6644
6646	13	12	Good	96.63	1.29	1.08	1.00	.68	.32	2.12	77	79	.98	do	2.16	2.93	.85	6646

Washington □:																	
8384	(1)	5	...do...	96.76	.09	2.33	.82	.45	.37	1.22	62	76	.82	...do...	1.98	2.57	.82	8384
Windham □:																	
6618	14	8	Fair	90.06	8.28	.72	.94	.66	.28	2.36	66	75	.88	...do...	2.85	3.42	.97	6618
6619	12	8	...do...	79.43	18.93	.81	.83	.52	.31	1.68	68	80	.85	...do...	2.87	3.71	.95	6619
6620	12	10	Good	83.78	12.90	2.32	1.00	.70	.30	2.33	84	88	.95	...do...	3.31	3.88	1.11	6620
Windsor □:																	
8368	13	9	...do...	96.88	.64	1.57	.91	.62	.29	2.14	73	73	1.00	...do...	2.36	3.01	.85	8368
8369	10	7+	...do...	96.85	.41	1.86	.88	.55	.33	1.67	72	78	.92	...do...	2.28	3.13	.88	8369
8371	(1)	7+	...do...	97.56	.22	1.38	.84	.56	.28	2.00	78	66	1.18	...do...	2.25	2.98	.84	8371
8377	(1)	9	...do...	95.65	1.05	2.52	.78	.47	.31	1.52	56	77	.72	...do...	1.94	2.62	.67	8377
8380	(1)	8	Poor	94.17	.44	4.58	.81	.52	.29	1.79	65	74	.87	...do...	2.02	2.64	.81	8380
8381	(1)	10	Fair	91.93	4.09	3.16	.82	.49	.33	1.48	56	90	.62	...do...	2.11	3.07	.69	8381
8379	(1)	10	...do...	96.70	.43	1.99	.88	.59	.29	2.03	65	84	.77	...do...	2.28	3.00	.51	8379
8430	12	11	...do...	93.16	2.76	3.31	.77	.50	.27	1.84	50	63	.79	...do...	....	2.20	.66	8430
8476	(1)	12+	Poor	93.68	2.47	3.01	.84	.55	.29	1.90	70	73	.95	...do...	1.86	2.76	.67	8476
Average (63)	[2] 12	11	....	88.39	8.37	2.32	.92	.54	.38	1.42	66	89	.74	....	[3] 2.70	3.39	.92	....
Maximum	16	20	....	97.56	25.00	5.51	1.41	.70	.81	2.88	93	132	1.59	....	4.06	4.63	1.30	....
Minimum	8	5	....	70.40	.09	.50	.77	.37	.24	.61	37	38	.37	....	1.86	2.35	.51	....

WEST VIRGINIA.

Grant □:																	
7501	12	13	Good	90.62	6.37	1.59	1.42	0.82	0.60	1.37	93	142	0.65	Slight	4.09	4.42	1.53	7501
7502	10	13	...do...	95.50	2.47	.62	1.41	.82	.59	1.39	71	126	.57	...do...	4.05	4.23	1.13	7502
7503	10	16	Fair	90.48	5.97	2.10	1.45	.83	.62	1.34	104	133	.78	...do...	4.64	4.70	1.56	7503
7504	14	11	...do...	94.48	3.59	.84	1.09	.65	.44	1.48	88	109	.80	None	3.44	3.74	1.25	7504
7505	15	11	Good	97.25	.98	.61	1.16	.71	.45	1.48	91	115	.79	...do...	3.04	3.44	1.15	7505
Greenbrier □:																	
6687	12	11	...do...	84.06	13.69	.88	1.37	.91	.46	1.98	102	102	1.00	Slight	3.72	4.99	1.34	6687
Monroe □:																	
6688	13	11	Fair	85.65	10.82	1.87	1.66	1.14	.52	2.18	124	130	.95	...do...	4.95	5.90	1.72	6688
Average (7)	12	12	....	91.15	6.27	1.21	1.37	.84	.53	1.58	96	122	.79	....	3.99	4.49	1.38	....
Maximum	15	16	....	97.25	13.69	2.10	1.66	1.14	.62	2.18	124	142	1.00	....	4.95	5.90	1.72	....
Minimum	10	11	....	84.06	.98	.61	1.09	.65	.44	1.34	71	102	.57	....	3.04	3.44	1.13	....

UNITED STATES.

Average (283)	[4] 13	11	....	91.89	5.46	1.70	0.95	0.62	0.33	1.88	74	82	.90	....	2.68	[5] 3.34	0.91	....
Maximum	21	20+	....	98.62	37.30	5.84	1.66	1.14	.81	4.07	140	149	2.29	....	4.95	5.90	1.72	....
Minimum	8	7	....	57.04	0.09	0.00	.76	.37	.21	.61	37	31	.37	....	1.85	2.20	.51	....

[1] Undetermined. [2] Average of 54 determinations. [3] Average of 62 determinations. [4] Average of 247 determinations. [5] Average of 282 determinations.

TABLE X.—*Results of physical and chemical examination of maple-sugar samples*—Continued.

QUEBEC, CANADA

Serial number and county or district.	Physical properties: Color: Sugar.	Physical properties: Color: Sirup.	Physical properties: Taste.	Chemical analysis: Sucrose (Clerget).	Chemical analysis: Invert sugar.	Chemical analysis: Undetermined.	Chemical analysis: Total ash.	Chemical analysis: Soluble ash.	Chemical analysis: Insoluble ash.	Chemical analysis: Soluble ash / Insoluble ash.	Chemical analysis: Alkalinity: Soluble ash.	Chemical analysis: Alkalinity: Insoluble ash.	Chemical analysis: Alkalinity: Soluble ash / Insoluble ash.	Tannin reaction.	Lead number: Winton.	Lead number: Ross.	Malic acid value.	Serial number.
Shefford, Brome, and Stanstead:				Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.		Cc.	Cc.						
6716	8	20+	Strong	74.11	18.20	6.47	1.22	0.60	0.62	0.96	50	90	0.55	None	4.13	4.51	1.35	6716
6717	10	20+	do	91.22	4.15	3.29	1.34	.69	.65	1.06	54	118	.46	Good	3.69	4.37	1.22	6717
6938	13	13+	Poor	90.38	6.95	1.83	.84	.60	.24	2.50	75	53	1.41	Slight	2.36	3.08	.78	6938
6939	11	14	do	67.57	27.31	4.24	.88	.49	.39	1.26	65	93	.70	do	2.71	3.64	.96	6939
6940	13	10	Good	92.74	4.61	1.83	.82	.46	.36	1.28	65	82	.80	None	2.43	3.33	.87	6940
6941	11	18	Fair	83.38	11.71	3.88	1.09	.48	.61	.78	66	130	.51	Slight	3.13	3.94	1.10	6941
6942	12	13	Good	93.87	3.99	1.10	1.04	.60	.44	1.36	68	103	.66	None	3.22	3.96	1.01	6942
6943	11	18	Fair	93.31	4.50	1.18	1.01	.45	.56	.80	50	124	.40	Slight	3.69	3.77	1.02	6943
6944	12	17	do	90.87	6.86	1.30	.97	.51	.46	1.11	66	99	.67	do	2.42	3.99	1.00	6944
6945	11	12+	do	91.56	5.86	1.75	.83	.49	.34	1.44	61	78	.81	do	2.35	3.42	.77	6945
6946	8	20	Strong	88.31	9.03	1.62	1.04	.48	.56	.86	67	119	.56	do	3.32	4.45	1.04	6946
6947	15	8	Good	89.22	8.93	1.04	.81	.46	.35	1.31	57	79	.72	None	2.48	3.56	.88	6947
6948	13	12	do	91.92	5.61	1.63	.84	.50	.34	1.47	67	76	.89	Slight	3.52	3.31	.80	6948
6949	12	13	Poor	94.27	2.77	2.12	.84	.44	.40	1.10	63	88	.71	None	2.43	3.38	.92	6949
6950	13	9	Good	90.04	9.09	.02	.85	.47	.38	1.24	62	86	.72	do	2.46	3.60	.94	6950
6951	12	15	Fair	89.04	6.61	3.39	.96	.64	.32	2.00	77	78	.98	Slight	2.68	3.56	.91	6951
6952	8	20+	Strong	86.80	8.83	3.44	.93	.39	.54	.72	52	117	.44	do	2.46	3.83	.98	6952
6953	10	20+	do	88.17	6.28	4.39	1.16	.61	.55	1.11	79	128	.61	do	2.87	4.24	1.15	6953
6954	(1)	20+	Fair	90.05	4.78	4.26	.91	.62	.29	2.14	69	83	.83	Strong	2.48	3.01	.81	6954
6955	(1)	13	Good	96.59	.88	1.67	.86	.51	.35	1.46	88	65	1.36	None	2.03	2.74	.77	6955
6956	(1)	13	Fair	93.51	2.15	3.37	.97	.71	.26	2.73	80	81	.98	do	2.90	3.39	1.03	6956
6957	(1)	13	do	74.66	19.13	5.28	.93	.64	.29	2.21	71	82	.86	Slight	2.99	4.01	1.04	6957
7596	17	7	Good	92.97	5.42	.83	.78	.51	.27	1.89	64	73	.87	None	2.16	2.82	.79	7596
7599	8−	20+	Strong	81.26	13.98	3.35	1.41	.68	.73	.93	84	144	.58	Strong	3.12	3.63	.96	7599
Average (24)	[2] 11+	15		88.16	8.23	2.64	.97	.54	.43	1.25	66	94	.70		2.83	[3] 3.66	.96	
Maximum	17	20+		96.59	27.31	6.47	1.41	.71	.73	2.73	88	144	1.41		4.13	4.51	1.35	
Minimum	8	7		67.57	.88	.02	.78	.39	.24	.72	50	53	.40		2.03	2.74	.77	

Joliette:																		
7710	9	12	Good	87.73	8.51	2.83	.93	.03	.30	2.10	76	85	.89	Trace	2.86	(1)	.90	7710
7715	10	14	do	94.38	4.72	.03	.87	.63	.24	2.62	70	58	1.21	do	2.11	(1)	.62	7715
7717	9	13	do	93.95	2.73	2.36	.96	.64	.32	2.00	83	86	.96	None	2.72	(1)	.90	7717
7718	13	10	do	90.90	5.38	2.94	.78	.53	.25	2.12	78	66	1.18	do	2.34	(1)	.77	7718
7719	10	10+	do	88.36	7.64	3.14	.85	.59	.26	2.27	80	72	1.11	do	2.57	(1)	.86	7719
7720	11	14+	do	92.71	4.02	2.22	1.05	.80	.25	3.20	116	75	1.54	do	3.10	(1)	.98	7720
7721	9	18	Fair	83.43	12.00	3.42	1.15	.80	.35	2.28	115	101	1.14	Trace	3.69	(1)	1.21	7721
7729	8–	20+	Bad	83.25	10 76	4.89	1.10	.70	.40	1.75	87	113	.77	do	3.56	(1)	1.23	7729
7730	8	10	Good	91.65	4.61	2.96	.78	.54	.24	2.25	71	68	1.04	None	2.37	(1)	.79	7730
7738	8–	18	do	84.67	8.90	5.20	1.23	.83	.40	2.07	120	120	1.00	Trace	3.70	(1)	1.34	7738
7739	8–	20+	Bad	80.99	11.70	5.97	1.34	.72	.62	1.15	93	141	.66	do	3.49	(1)	1.34	7739
7742	8–	20+	Burned	70.35	21.70	6.54	1.41	.68	.73	.93	86	152	57	do	3.32	(1)	1.30	7742
Average (12)	9+	15		86.79	8.55	3.62	1.04	.67	.37	1.81	90	95	.95		2.99		1.02	
Maximum	13	20+		94.38	21.70	6.54	1.41	.83	.73	3.20	1.20	152	1.54		3.70		1.34	
Minimum	8–	10		70.35	2.73	.03	.78	.53	.24	.93	70	58	.57		2.11		.62	
Arthabaska, Megantic, Beauce:																		
7708	9	12+	Good	94.11	2.27	2.62	1.00	.61	.39	1.57	76	95	.80	None	2.50	(1)	.88	7708
7709	8	13	do	90.85	5.24	2.95	.96	.50	.46	1.09	62	89	.70	do	2.61	(1)	.90	7709
7711	11	12	Fair	94.00	3.91	1.05	1.04	.43	.61	.70	65	62	1.05	do	2.55	(1)	.65	7711
7712	13	11+	do	93.27	3.04	2.72	.97	.67	.30	2.23	85	79	1.08	do	2.96	(1)	.97	7712
7713	10	15	do	89.67	5.46	3.74	1.13	.63	.50	1.26	81	112	.72	Trace	3.30	(1)	1.13	7713
7714	13	12+	Good	93.51	3.45	2.14	.90	.63	.27	2.33	74	79	.93	None	2.47	(1)	.78	7714
7716	10	16	do	92.22	3.95	2.85	1.08	.59	.49	1.21	83	103	.80	do	3.24	(1)	1.10	7716
7722	8–	20+	Fair	79.88	14.05	4.91	1.16	.55	.61	.90	97	138	.70	Trace	3.48	(1)	1.20	7722
7723	8–	20+	do	81.83	12.83	4.03	1.31	.72	.59	1.22	116	138	.84	do	3.59	(1)	1.26	7723
7724	8–	20	Good	89.59	4.91	4.32	1.18	.79	.39	2.02	117	110	1.06	do	3.77	(1)	1.28	7724
7725	8–	20	Fair	88.64	6.40	3.87	1.09	.68	.41	1.65	104	111	.93	do	3.79	(1)	1.25	7725
7726	10	16	do	87.32	6.55	5.08	1.05	.68	.37	1.84	88	91	.96	do	3.22	(1)	1.11	7726
7727	9	20	Good	89.96	4.86	4.07	1.11	.71	.40	1.78	90	106	.85	do	3.10	(1)	1.06	7727
7728	10	16	do	90.57	5.06	3.07	1.00	.60	.40	1.50	81	102	.79	do	3.02	(1)	1.08	7728
7731	11	14	do	91.99	3.59	3.47	.95	.69	.26	2.65	87	72	1.20	None	2.41	(1)	.77	7731
7732	11	14+	do	91.14	5.50	2.07	.89	.65	.24	2.70	82	71	1.15	do	2.64	(1)	.82	7732
7733	8–	20+	Bad	84.44	10.50	3.86	1.20	.76	.44	1.73	93	115	.80	Trace	3.24	(1)	1.06	7733
7734	8–	20+	Fair	89.46	4.63	4.78	1.13	.73	.40	1.82	90	113	.80	do	3.19	(1)	1.05	7734
7735	8–	20+	do	88.29	6.64	4.10	.97	.49	.48	1.02	69	106	.65	do	3.40	(1)	1.12	7735
7736	8–	20+	do	83.67	9.40	5.37	1.56	.78	.78	1.00	102	158	.64	do	3.20	(1)	1.29	7736
7737	8–	20+	do	89.10	5.29	4.47	1.17	.73	.44	1.66	88	113	.78	do	2.80	(1)	1.00	7737
7740	10	13	Good	90.09	5.27	3.80	.84	.55	.29	1.90	72	82	.87	None	2.49	(1)	.87	7740
7741	9	11	do	88.26	7.10	3.73	.91	.58	.33	1.76	78	88	.88	do	2.72	(1)	.92	7741
7743	8–	20+	Burned	58.92	35.26	5.06	.76	.31	.45	.69	42	103	.40	Trace	1.86	(1)	.75	7743
7744	8–	20+	Good	85.23	8.52	5.00	1.25	.77	.48	1.60	93	126	.73	do	3.24	(1)	1.12	7744
7745	8–	20+	Burned	81.20	10.82	6.28	1.70	.70	1.00	.70	93	190	.49	do	3.47	(1)	1.40	7745
7746	8–	20+	do	83.54	11.02	4.23	1.21	.77	.44	1.75	89	125	.71	do	2.98	(1)	1.06	7746
7747	8–	20+	do	69.13	23.46	6.20	1.21	.44	.77	.57	94	149	.63	do	3.00	(1)	1.27	7747
7748	8–	20+	do	66.45	26.04	6.34	1.17	.35	.82	.43	80	146	.54	do	3.14	(1)	1.39	7748
7749	8	20+	do	85.22	8.21	5.38	1.19	.60	.59	1.01	107	141	.75	do	3.34	(1)	1.25	7749
7750	8	20+	do	77.16	13.42	8.18	1.24	.56	.68	.82	99	146	.68	do	3.84	(1)	1.47	7750

[1] Undetermined. [2] Average of 20 determinations. [3] Average of 26 determinations.

TABLE X.—*Results of physical and chemical examination of maple-sugar samples*—Continued.

QUEBEC, CANADA—Continued.

Serial number and county or district.	Physical properties. Color. Sugar.	Physical properties. Color. Sirup.	Physical properties. Taste.	Chemical analysis. Sucrose (Clerget).	Invert sugar.	Undetermined.	Total ash.	Soluble ash.	Insoluble ash.	Soluble ash / Insoluble ash.	Alkalinity. Soluble ash.	Alkalinity. Insoluble ash.	Alkalinity. Soluble ash / Insoluble ash.	Tannin reaction.	Lead number. Winton.	Lead number. Ross.	Malic acid value.	Serial number.
Arthabaska, Megantic, Beauce—Contd.				Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.		Cc.	Cc.						
7500	10	13	Fair	93.67	3.56	1.86	0.91	0.66	0.25	2.64	69	66	1.04	None	4.02	3.53	0.94	7500
7520	13	19	Poor	80.24	14.43	4.16	1.17	.77	.40	1.62	89	100	.89	Trace	3.46	(1)	1.11	7520
7522	8	20+	do	86.00	7.26	5.61	1.13	.69	.44	1.56	82	113	.72	None	3.80	(1)	.99	7522
7523	10	20	do	91.54	2.06	4.99	1.41	.80	.61	1.31	78	138	.56	Trace	3.27	(1)	1.15	7523
7597	8−	20	do	83.75	14.04	.97	1.24	.72	.52	1.38	70	117	.60	Slight	3.31	4.07	.89	7597
7449	8−	20+	do	82.65	10.46	5.52	1.37	.58	.79	.73	65	148	.44	do	3.34	(1)	1.15	7449
7478	11	13	do	88.94	4.75	5.45	.86	.47	.39	1.20	57	96	.59	None	2.30	(1)	.85	7478
7479	12	18	do	89.50	5.44	4.09	.97	.55	.42	1.31	69	103	.67	Trace	2.91	(1)	.91	7479
7484	10	20+	do	81.61	12.37	4.79	1.23	.89	.34	2.61	91	92	.98	Slight	3.47	(1)	1.02	7484
7651	8	20+	do	76.96	16.20	5.73	1.11	.62	.49	1.27	67	116	.58	do	3.82	(1)	1.06	7651
7658	8−	20+	do	86.34	7.13	4.35	1.18	.66	.52	1.26	79	118	.67	do	3.62	(1)	1.13	7658
7659	12	20+	do	75.05	17.29	6.11	1.55	.67	.88	.76	76	169	.45	do	4.14	(1)	1.51	7659
7814	8	20+	Good	85.12	9.10	4.83	.95	.54	.41	1.31	85	106	.80	Trace	3.24	(1)	1.15	7814
Average (44)	9	17+		85.46	9.11	4.31	1.12	.63	.49	1.28	83	112	.74		3.16	(1)	1.07	
Maximum	13	20+		94.11	35.26	8.18	1.70	.89	1.00	2.70	117	190	1.20		4.14	(1)	1.51	
Minimum	8−	11		58.92	2.06	1.05	.76	.31	.24	.43	42	62	.40		1.86	(1)	.65	
Canada:																		
Average (80)	10	16+		86.48	8.76	3.70	1.06	.61	.45	1.36	79	104	.76		3.04	(1)	1.03	
Maximum	17	20+		96.59	35.26	8.18	1.70	.89	1.00	3.20	120	190	1.54		4.14	(1)	1.51	
Minimum	8−	7		58.92	.88	.02	.76	.31	.24	.43	42	58	.40		1.86	(1)	.62	
United States and Canada:																		
Average (363)	12+	13+		90.69	6.19	2.14	.98	.62	.36	1.69	75	87	.86		2.76	[2] 3.50	.93	
Maximum	21	20+		98.62	35.26	8.18	1.70	1.14	1.00	4.07	140	190	2.29		4.95	[2] 5.90	1.72	
Minimum	8−	7		57.04	.00	.00	.76	.30	.21	.43	42	31	.37		1.85	[2] 2.20	.51	

[1] Undetermined.

[2] Average of 308 determinations.

DISCUSSION OF RESULTS.

COLOR.

Sugar.—The color of a maple sugar, although not necessarily an indication of its quality, is influenced by the crystallization and by the dryness of the sugar. Very dark maple sirup, if free from sediment, when boiled down nearly to dryness and stirred gives a very light-colored sugar. If this sugar is powdered, the color and appearance are similar to those of the ordinary powdered cane sugar, although it possesses a maple flavor. Such sugar can also be produced with greater ease from a light-colored sirup. The color of the sugars varies from 8, the darkest, to 21, the lightest, the average of the individual States showing slight variations from 12 to 15. No comparison has been made between the Canadian and the United States samples.

Sirup.—The average color of the United States sugar-sirup samples is 11, which is three points darker than that of the sap sirups. Table XI shows the average color of the sugar sirups as well as that of the sap sirups for the several States.

TABLE XI.—*Average color of sugar sirup and sap sirup, by States.*

State.	Sugar sirup	Sap sirup.[1]	State.	Sugar sirup.	Sap sirup.[1]
Indiana	10+	10+	New York	10	7
Maine	11	8+	Ohio	10	8
Maryland	11	(2)	Pennsylvania	11	8
Massachusetts	9	7	Vermont	11	9
Michigan	11	8+	West Virginia	12	9
New Hampshire	10	8	United States	11	8+

[1] U. S. Dept Agr., Bur. Chem. Bul. 134. [2] No sample.

In only one State, Indiana, is the color of the sap sirup equal to the sugar sirup, there being in all others a difference of at least two points.

TASTE.

The flavor of a maple product is an indescribable property. It is usually possible for a person with an acute sense of taste to differentiate between sap sirup and sugar sirup after a very few trials.

SUCROSE.

The average percentage of sucrose in the sugars when reduced to the dry basis is 91.89, with extremes of 98.62 and 57.04. About 55 of the 283 samples from the United States molded in storage before analysis and in a few cases started to ferment. If the analytical results on these had been excluded, the average percentage of sucrose would be 94.36 instead of 91.89. For sap sirups the average figure for sucrose when calculated to dry basis is 95.18 per cent.

INVERT SUGAR.

The extreme percentages of invert sugar in the United States are 37.30 and 0.09, with an average percentage of 5.46, which would be 3.09 per cent if the results of the moldy sugar were not included. This increase, about 50 per cent higher than in the case of sap sirups, occurs because of the inversion of sucrose due to the extra concentration and heat when a sap sirup is made into a sugar. About 30 per cent of the samples have less than 1 per cent of invert sugar, whereas 53 per cent of corresponding samples of sap sirup have less than 1 per cent of invert sugar.

Table XII shows that where large quantities of reducing sugars are present in maple sugar the sucrose equivalent of 1 per cent reducing sugar is 0.30, which is very close to that of true invert sugar of equal parts of dextrose and levulose, but where small percentages of reducing sugars are present, there seems to be a large excess of levulose, and in many cases a levorotatory substance other than levulose is indicated. This was also noted with sap sirup.[1]

TABLE XII.—*Comparison of sucrose equivalents of 1 per cent of reducing sugar when large and small amounts are present.*

Serial No.	Reducing sugar calculated as invert.	Difference in direct polarization and in sucrose by Clerget.	Sucrose equivalent of 1 per cent reducing sugar.
Large amounts of reducing sugar:	*Per cent.*		
6459	9.61	3.46	0.37
6545	7.83	3.35	.43
6598	9.49	4.52	.47
6624	7.70	3.94	.51
6700	7.19	3.71	.51
6718	14.27	6.16	.43
6876	6.92	3.00	.43
6968	11.54	5.28	.45
8438	7.27	3.02	.41
8446	8.25	2.20	.26
Small amounts of reducing sugar:			
7510	0.66	2.67	4.04
7518	.41	2.57	6.26
7525	.58	2.77	4.77
7546	.75	2.07	2.76
7548	.22	1.84	7.37
8344	.65	1.00	1.54
8448	.66	2.02	3.06
8472	.96	1.70	1.77
8457	.78	1.80	2.31
8462	.51	1.30	2.55

ASH.

Total ash.—In the United States samples the average ash content is 0.95 per cent, with extremes of 1.66 and 0.76 per cent, while with Canada included the average is 0.98 per cent, with extremes of 1.70 and 0.76. The average for sap sirups for the United States is 1.02 per cent, with extremes of 1.68 and 0.68. Including Canada, the

[1] U. S. Dept. Agr., Bur. of Chem. Bul. 134, p. 65.

average is 1 per cent, with the same extremes. Grouping the individual determinations for ash by States and by 0.05 and 0.1 per cent differences, the results in Table XIII are obtained.

TABLE XIII.—*Total ash content of sugar, by locality.*

Ash content.	Number of samples.													Percentage of samples.
	Ind.	Me.	Md.	Mass.	Mich.	N. H.	N. Y.	Ohio.	Pa.	Vt.	W. Va.	Canada.	Total.	
Per cent.														
0.00 to 0.76....	......	......	......	......	......	......	......	[1] 1	......	......	......	[1] 1	2	0.7
.77 to .79....	......	1	1	......	4	......	7	2	7	8	......	3	33	9.1
.80 to .84....	1	......	3	......	4	4	5	5	8	19	......	7	56	15.4
.85 to .89....	2	......	1	1	2	2	12	3	2	7	......	7	39	10.7
.90 to .94....	3	1	3	4	6	3	11	7	4	7	......	7	56	15.4
.95 to .99....	3	2	1	4	4	2	9	6	4	6	......	10	51	14.0
1.00 to 1.09....	3	......	......	5	2	......	10	2	5	9	1	11	48	13.2
1.10 to 1.19....	3	......	2	......	1	1	......	3	8	2	1	15	36	9.9
1.20 to 1.29....	2	......	......	......	......	......	1	1	5	4	......	9	22	6.0
1.30 to 1.39....	......	......	......	......	......	......	1	......	......	......	1	4	6	1.6
1.40 to 1.49....	1	......	......	......	......	......	......	1	......	1	3	3	9	2.5
1.50 to 1.59....	1	......	......	......	......	......	......	......	......	......	......	2	3	.8
1.60 to 1.70....	......	......	......	......	......	......	......	......	......	......	[2] 1	[3] 1	2	.7
Total....	19	4	11	14	23	12	56	31	43	63	7	80	363	100.0

[1] 0.76. [2] 1.66. [3] 1.70.

The largest number of samples have a content of ash ranging from 0.80 to 1.10 per cent, and nearly 88 per cent of the samples range from 0.77 to 1.20 per cent. The lowest ash content found in this examination, 0.76 per cent, was obtained in a sample from Ohio and in one from Canada. In some of the experimental work, however, ash contents as low as 0.72 per cent were found. These total ash figures may be considered abnormal, as they were found in sirup the lead number, malic acid value, and insoluble ash content of which were far above the minimum figures.

TABLE XIV.—*Comparison of percentage of samples of sap and sugar sirup with varying ash content.*

Ash content.	Maple-sap sirup.	Maple-sugar sirup.	Ash content.	Maple-sap sirup.	Maple-sugar sirup.
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
0.00 to 0.76....................	0.2	0.7	1.10 to 1.19....................	12.3	9.9
.77 to .79....................	3.7	9.1	1.20 to 1.29....................	6.0	6.0
.80 to .84....................	11.2	15.4	1.30 to 1.39....................	3.7	1.6
.85 to .89....................	11.0	10.7	1.40 to 1.49....................	.4	2.5
.90 to .94....................	17.7	15.4	1.50 to 1.59....................	.6	.8
.95 to .99....................	12.4	14.0	1.60 to 1.70....................	1.0	.7
1.00 to 1.09....................	19.8	13.2			

The same percentage (88.4) of samples in both kinds of sirup have ash contents up to 1.20 per cent, although 36 per cent of the sugar samples and 26 per cent of the sap sirups have an ash content between 0.77 and 0.89 per cent. The appearance of the ash was not regular, a few samples being very green, while many were white or light gray. The appearance of the ash depends upon the method of burning.

Soluble and insoluble ash.—The insoluble ash in the United States samples shows an average figure of 0.33 per cent, with extremes of 0.81 and 0.21 per cent, but when Canada is included, the average figure is 0.36 per cent, with extremes of 1 and 0.21 per cent. These again are somewhat lower than the figures obtained for sap sirup. One sample from Michigan, one from Ohio, and one from Pennsylvania had only 0.22 per cent of insoluble ash, and another from Pennsylvania had 0.21 per cent. The total ash in each of these instances was not low, but was near the minimum line. The results obtained by grouping the samples by localities and dividing the insoluble ash contents into classes by 0.10 per cent are given in Table XV.

TABLE XV.—*Insoluble ash content of sugar, by locality.*

Insoluble ash content.	Number of samples.													Percentage of samples.
	Ind.	Me.	Md.	Mass.	Mich.	N. H.	N. Y.	Ohio.	Pa.	Vt.	W. Va.	Canada.	Total.	
Per cent.														
Below 0.23					[1] 1			[1] 1	[2] 2				4	1.4
0.23	4	1	1	4	8		7	6	4				35	9.6
.24 to 0.29	5	1	5	8	6	6	29	5	14	18		15	112	30.8
.30 to .39	4	2	4	2	7	5	15	17	14	24		18	112	30.8
.40 to .49	2		1		1	1	4	2	6	7	3	22	49	13.5
.50 to .59	3								2	8	2	9	24	6.6
.60 to .69							1		1	5	2	8	17	4.7
.70 to .79	1											5	6	1.6
.80 to .89										[3] 1		2	3	0.8
.90 to .99														
1.00 to 1.09												[4] 1	1	0.2
Total	19	4	11	14	23	12	56	31	43	63	7	80	363	100.0

[1] 0.22. [2] 0.21, 0.22. [3] 0.81. [4] 1.00.

From this it is seen that 72.6 per cent of the samples have an insoluble ash content of less than 0.40 per cent. In Canada 59 per cent of the samples have a higher number than that, while all the West Virginia samples have a higher insoluble ash content than 0.40 per cent. The other States show their largest figures below 0.40 per cent.

Percentage of soluble ash divided by percentage of insoluble ash.—The average figure is 1.69; that is, the percentage of insoluble ash is about 55 per cent of the soluble ash. The highest is 4.07 and the lowest, 0.43. Among the sap sirups some 29 samples, or 6 per cent, showed a ratio below 1.0; among the sugar sirups 8 per cent were found with this low ratio. These samples were confined to the State of Vermont and to Canada. From Table XVI, showing the data by groups of 0.01 and 0.25, it is seen that the largest percentage of samples falls between 1.25 and 2.75.

TABLE XVI.—*Soluble and insoluble ash content of sugar, by locality.*

Soluble ash divided by insoluble ash.	Number of samples.													Percentage of samples.
	Ind.	Me.	Md.	Mass.	Mich.	N. H.	N. Y.	Ohio.	Pa.	Vt.	W. Va.	Canada.	Total.	
Per cent.														
0.0 to 0.59...												[1] 2	2	0.7
.60 to .69...										2		1	3	.8
.70 to .79...										4		6	10	2.7
.80 to .89...										5		3	8	2.2
.90 to .99...										2		4	6	1.6
1.00 to 1.24...	3		2			1	3	3	1	7		13	33	9.1
1.25 to 1.49...	1				1	4	7	1	8	6	5	13	46	12.7
1.50 to 1.74...	1				3		3	5	6	12		8	38	10.4
1.75 to 1.99...		1	2		3	1	7	3	2	9	1	8	37	10.2
2.00 to 2.24...	2	1	3	2	3	2	6	5	9	10	1	10	54	14.8
2.25 to 2.49...	4	2	3	1	4	1	8	5	10	5		4	47	13.0
2.50 to 2.74...	3		1	3	4	3	12	7	3			7	43	11.8
2.75 to 2.99...	4			3	1		5	1	3	1			18	5.0
3.00 to 3.49...				5	4		3	1				1	14	3.8
3.50 to 3.99...	1						1		1				3	.8
4.00 to 4.10...							[2] 1						1	.4
Total..	19	4	11	14	23	12	56	31	43	63	7	80	363	100.0

[1] 0.43, 0.57. [2] 4.07.

Alkalinity of soluble and insoluble ash.—This determination is expressed in the number of cubic centimeters of tenth-normal acid necessary to neutralize the ash of 100 grams of sirup. For insoluble ash, which is chiefly calcium carbonate, the average figure is 87 cc, the extremes being 190 and 31. Since 1 cc of tenth-normal acid is equal to 0.005 gram of calcium carbonate, the 87 cc are equivalent to 0.435 gram of calcium carbonate. The actual average percentage of insoluble ash is 0.36, which is 0.07 gram lower than that calculated from the alkalinity. The average figure for soluble ash is 75 cc, with extremes of 140 and 42. Considering the soluble ash to be potassium carbonate, the 75 cc would equal 0.518 gram of potassium carbonate. The average percentage of soluble ash is 0.62, which is 0.11 gram higher than that calculated from the alkalinity. This may be accounted for by the presence of alkaline salts other than potash.

LEAD NUMBER.

The average lead numbers for the individual States vary to a great extent, as shown in Table XVII:

TABLE XVII.—*Average of the Winton and Ross lead numbers, by States.*

No.	Locality.	Winton lead number.	Locality.	Ross lead number.
1	West Virginia	3.99	West Virginia	4.49
2	Indiana	3.04	Indiana	3.73
3	Canada	3.04		[1]
4	Pennsylvania	2.84	Pennsylvania	3.34
5	Ohio	2.74	Ohio	3.29
6	Vermont	2.70	Vermont	3.39
7	Massachusetts	2.67	Massachusetts	3.35
8	Maryland	2.61	Maryland	2.99
9	Michigan	2.52	Michigan	3.33
10	New Hampshire	2.50	New Hampshire	3.50
11	Maine	2.43	Maine	3.40
12	New York	2.42	New York	3.05

[1] Canada is not included, as this determination was not made on all the samples.

West Virginia and Indiana stand at the top in each determination, the rest of the localities varying in their places. It is noted that in each case the Ross lead number is higher than the Winton. The average for the Winton number in the United States samples is 2.68, with extremes of 4.95 and 1.85. Including the results from the Canadian samples the average is 2.76, with the same extremes. With the Ross number, the United States average is 3.34, with extremes of 5.90 and 2.20. The increase in lead number by the Ross method averages 0.58.

Grouping the lead number by localities into divisions varying by 0.25 and placing the samples with these figures in such groups, the results in Table XVIII are obtained.

TABLE XVIII.—*Lead number of sugar, by locality.*

Lead number.	Number of samples.													Percentage of samples.
	Ind.	Me.	Md.	Mass.	Mich.	N.H.	N.Y.	Ohio.	Pa.	Vt.	W. Va.	Canada.	Total.	
Winton:														
0.00 to 1.84	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1.85 to 1.99	.....	.....	.....	.....	3	2	3	2	4	7	.....	1	22	6.1
2.00 to 2.24	1	.....	3	1	4	1	16	7	9	11	.....	3	56	15.5
2.25 to 2.49	1	2	3	5	6	5	16	3	6	12	.....	15	74	20.5
2.50 to 2.74	4	1	1	2	3	1	14	6	2	5	.....	10	49	13.6
2.75 to 2.99	5	.....	1	3	3	2	4	3	4	6	.....	7	38	10.5
3.00 to 3.24	3	.....	3	2	2	.....	1	3	6	5	1	15	41	11.3
3.25 to 3.49	1	.....	.....	1	2	1	.....	2	1	7	1	14	30	8.3
3.50 to 3.74	1	.....	.....	.....	.....	.....	1	3	4	6	1	8	24	6.6
3.75 to 3.99	1	1	.....	.....	.....	.....	.....	1	5	2	.....	4	12	3.9
4.00 to 4.49	2	.....	.....	.....	.....	.....	.....	1	2	1	2	3	11	3.1
4.50 to 5.00	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2	.....	2	0.6
Total	19	4	11	14	23	12	[1] 55	31	43	[1] 62	7	80	361	100.0
Ross:														
0.00 to 2.24	.....	.....	.....	.....	.....	.....	.....	1	1	1	.....	.....	3	1.1
2.25 to 2.49	.....	.....	2	.....	.....	.....	3	2	4	2	.....	.....	13	4.6
2.50 to 2.74	.....	1	2	1	1	1	7	3	6	7	.....	.....	29	10.3
2.75 to 2.99	.....	.....	1	.....	3	1	14	4	10	7	.....	.....	40	14.2
3.00 to 3.24	4	.....	3	3	6	1	15	4	1	13	.....	.....	50	17.8
3.25 to 3.49	.....	.....	1	6	6	4	10	5	3	6	1	.....	42	14.9
3.50 to 3.74	8	2	1	3	4	.....	3	6	6	5	1	.....	39	13.9
3.75 to 3.99	2	1	1	1	1	3	2	4	2	11	.....	.....	28	10.0
4.00 to 4.24	3	.....	.....	.....	2	.....	.....	.....	2	6	1	.....	14	5.0
4.25 to 4.49	.....	.....	.....	.....	.....	2	.....	1	4	2	1	.....	10	3.6
4.50 to 4.74	2	.....	.....	.....	.....	.....	.....	1	2	3	1	.....	9	3.1
4.75 to 4.99	.....	.....	.....	.....	.....	.....	.....	.....	2	.....	1	.....	3	1.1
5.00 to 6.00	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	1	0.4
Total	19	4	11	14	23	12	[2] 54	31	43	63	7	.....	281	100.0

[1] Determinations not made on one sample. [2] Two not made.

In the total column of the Winton number, most of the samples have a number between 2.00 and 3.50. In some States the variation is rather small; for example, New York shows 83 per cent of samples between 2.00 and 2.74, Indiana 70 per cent of samples between 2.50 and 3.24 while in West Virginia no samples were found with a number below 3.00.

With the Ross number the largest percentage of samples falls between 2.50 and 3.99, New York showing 72 per cent between 2.75

and 3.49, Indiana nearly 50 per cent of samples with a lead number between 3.50 and 3.74, and West Virginia no samples below 3.25.

Ross[1] indicates that the excess of both lead subacetate and sugar exert a marked effect upon the lead subacetate precipitate and shows that the effect of the excess of sugar is relatively greater. In the procedure for his method potassium sulphate is added to the solution before the lead subacetate to overcome the solvent action of the sugar upon the lead precipitate. Ross believes this solvent action to be the cause of the lead number of mixtures of maple and cane sirup not being proportional to the percentage of maple present. The figures by Ross lead number given herein, however, apply only to sirups having a density of approximately 65 per cent solids which were made up from pure maple sugar, and the application of lead number determinations to mixtures of maple and cane sugar sirup has not been entered into in connection with this bulletin. In Table XIX the increase of the individual samples is grouped by differences of 0.10 and by States.

TABLE XIX.—*Differences between Winton and Ross lead numbers.*

Lead number.	Number of samples.												Percentage of samples.
	Ind.	Me.	Md.	Mass.	Mich.	N. H.	N. Y.	Ohio.	Pa.	Vt.	W. Va.	Total.	
Winton higher than Ross	......	......	......	......	......	......	......	2	......	......	......	2	0.7
Winton and Ross equal	......	......	......	......	......	......	......	......	......	1	......	1	.3
Ross higher by less than 0.10	......	......	......	......	......	......	1	3	4	......	1	9	3.2
Ross higher by more than:													
0.10	1	......	2	......	......	......	......	2	4	......	1	10	3.6
.20	......	......	3	1	......	......	2	3	2	1	1	13	4.6
.30	......	......	2	1	1	......	5	2	4	3	2	20	7.1
.40	2	1	1	1	......	......	11	1	8	8	1	34	12.2
.50	......	......	2	3	2	......	10	1	8	11	......	37	13.2
.60	3	......	......	2	4	......	7	4	5	6	......	31	11.1
.70	4	......	......	2	6	3	5	4	4	12	......	40	14.3
.80	6	1	......	1	5	3	7	3	1	10	......	37	13.2
.90	2	1	1	1	3	4	......	4	1	6	1	24	8.6
1.00	1	......	......	1	2	......	2	1	......	......	......	7	2.5
1.10	......	......	......	1	......	1	3	1	......	2	......	8	2.9
1.20	......	1	......	......	......	......	......	......	......	2	......	3	1.1
1.30	......	......	......	......	......	1	1	......	1	......	......	3	1.1
1.40	......	......	......	......	......	......	......	......	1	......	......	1	.3
Total	19	4	11	14	23	12	54	31	43	62	7	280	100.0
Difference:													
Average	69	93	38	68	81	100	63	55	50	69	50	......	......
Maximum	112	126	92	116	104	133	137	121	142	129	95	......	......
Minimum	48	49	16	29	35	74	8	......	3	......	6	......	......

The increase varies greatly in the samples, the greatest increase being 1.42 and the least 0.15. Eighty per cent of the samples show an increase of from 0.30 to 1. Table XX gives the results of samples that show little difference between the two numbers, from which it is seen that factors other than the solubility of the lead precipitate in the sugar solution enter into the amount of the lead number.

[1] U. S. Dept. Agr., Bur. Chem. Cir. 53.

TABLE XX.—*Samples with Winton and Ross lead numbers showing slight variation.*

State.	Serial No.	Lead numbers.		
		Winton.	Ross.	Difference.
Ohio	6315	3.61	3.57	−0.04
Do	6318	3.47	3.32	− .15
Vermont	6788	3.58	3.58	.00
New York	7561	2.37	2.45	+ .08
Ohio	6313	3.53	3.62	+ .09
Do	6373	2.16	2.22	+ .06
Do	6374	2.23	2.25	+ .02
Pennsylvania	6882	3.22	3.30	+ .08
Do	6884	2.77	2.86	+ .09
Do	6864	3.68	3.71	+ .03
Do	6872	3.69	3.74	+ .05
West Virginia	7503	4.64	4.70	+ .06

MALIC ACID VALUE.

The average of all determinations was 0.93, with extremes of 1.72 and 0.51. This average is a little below that obtained on sap sirups, 1.01, and the extremes are not as far apart as in sap sirups. The results by localities and groups of 0.10 and 0.25 are tabulated in Table XXI.

TABLE XXI.—*Malic acid value of sugar, by locality.*

Malic acid value.	Number of samples.													Percentage of samples.
	Ind.	Me.	Md.	Mass.	Mich.	N.H.	N.Y.	Ohio.	Pa.	Vt.	W. Va.	Canada.	Total.	
0.00 to 0.59	......	......	......	......	......	......	......	......	[1] 1	[2] 1	......	......	2	0.7
.60 to .69	......	1	1	......	6	......	3	2	3	8	......	2	26	7.2
.70 to .79	2	......	5	1	2	4	14	8	7	7	......	9	59	16.3
.80 to .99	8	3	3	9	12	4	30	7	16	26	......	25	143	39.2
1.00 to 1.24	7	......	2	4	3	4	9	12	14	19	2	29	105	29.0
1.25 to 1.49	2	......	......	......	......	......	......	1	2	2	2	14	23	6.3
1.50 to 1.74	......	......	......	......	......	......	......	......	......	......	3	1	4	1.3
Total	19	4	11	14	23	12	56	[3] 30	43	63	7	80	[3] 362	100.0

[1] 0.59. [2] 0.51. [3] One missing.

The largest number of samples falls in the groups from 0.70 to 1.24. Two samples show figures below 0.60, one from Pennsylvania with a value of 0.59, and one from Vermont with a value of 0.51, while in the sap sirup 6 out of the 480 showed values below 0.60, one being as low as 0.21.

TANNIN REACTION.

The ferric-chlorid test showed indications of tannin in nearly one-third of the samples, being very strong in 10 samples. In all cases where tannin was noted the color of the sirup was dark, and in most of these the flavor was poor. The fact that tannin was found in a larger number of the sugar-sirup samples than of the sap-sirup samples may be accounted for by the fact that less care was taken in the preparation of the maple sugar than in that of the sap sirup. Many

tests have been made of the fresh sap in different bushes with ferric chlorid, but in no case has a coloration due to tannin been noted. Tannin is present in sap that has stood during a rainstorm, as well as in dirty sap.

UNDETERMINED MATTER.

As this is a difference figure, it is influenced by the accuracy of the other determinations. The highest figure noted for the United States samples was 5.84, and the minimum was 0, the average being 1.70. This difference is almost entirely accounted for when ash, which is weighed as a carbonate, is calculated to a malate, in which condition it is supposed to occur naturally.

CANADIAN MAPLE SUGARS.

Comparison of Canadian sap sirups with those from the United States showed that they were darker in color and gave lower analytical results.[1] The same comparison on maple sugars shows that on an average the analytical figures for Canadian samples are slightly higher than those for the United States. Table XXII gives the average results.

TABLE XXII.—*Comparison of analytical results for Canadian and United States sugar.*

Determination.	United States samples (283).	Canadian samples (80).	Determination.	United States samples (283).	Canadian samples (80).
Sucrose............per cent..	91.89	86.48	Insoluble ash.......per cent..	0.33	0.45
Invert sugar............do....	5.46	8.76	Soluble ash.............do....	.62	.61
Undetermined..........do....	1.70	3.70	Winton lead number..........	2.68	3.04
Total ash...............do....	.95	1.06	Ross lead number............	[1]3.34	[2]3.66
			Malic acid value..............	.91	1.03
Total............do....	100.00	100.00			

[1] Average of determinations on 282 samples.
[2] Average of determinations on 26 samples. Determination not made on rest of the 80 samples.

The darker color of the Canadian samples was due to the process of manufacture rather than to the environment or climate, for products as light colored as those manufactured in the United States are made in Canada. Crudeness in the process leads to dark, strong-flavored products, which are of no value for consumption in that condition, but find a market in mixtures of maple and sugar sirups or for giving flavor to a sirup.

The Canadian samples may be grouped into three divisions, those coming from Beauce and the surrounding townships, those from the region below Montreal, centered around Sherbrook and Waterloo, and those above Montreal in Joliette Township. Figure 1 shows the relative location of these townships, as well as the average figures for the important analytical determinations.

[1] U. S. Dept. Agr., Bur. Chem. Bul. 134, pp. 75–76.

From this it is seen that the figures for the Beauce district are a little higher than those for the other two districts, the region below Montreal giving the lowest figures and that above Montreal the next lowest. This is apparently the direct opposite of the tendency of the sugar sirup of the United States.

EFFECT OF ENVIRONMENT ON THE COMPOSITION OF MAPLE SUGAR.

In the case of sap sirup, there is a relationship between the location of States and the composition of the product. Taking the average determinations for the States and localities in some of the

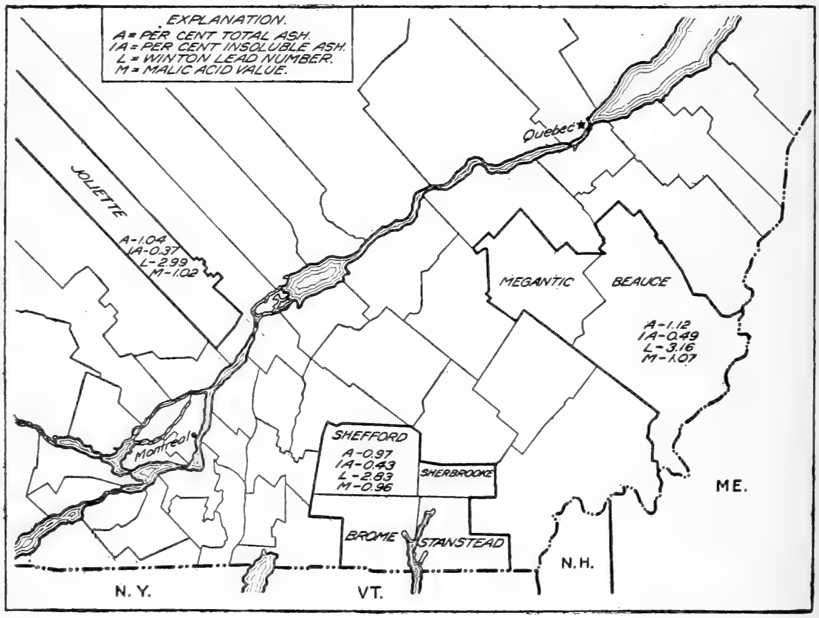

FIG. 1.—Map showing effect of environment on analytical results of maple sugar, Canada.

States, as one goes north there is a lower figure for total ash, lead number, and malic acid value. Tabulating the results of the maple sugar work in this way, the same general tendency is noted.

TABLE XXIII.—*Average analyses of samples, by localities.*

Determination.	Analyses.											
	W. Va.	Ind.	Ohio.	Md.	Pa.	Mich.	Mass.	N.Y.	Vt.	N.H.	Me.	Canada.
Sucrose..........per cent.	91.15	90.16	89.98	95.38	92.92	92.00	93.17	96.04	88.39	89.54	94.11	86.48
Invert sugar..........do...	6.27	5.64	6.52	1.89	4.92	4.63	5.44	2.33	8.37	7.71	4.06	8.76
Total ash............do...	1.37	1.08	.95	.91	.97	.90	.98	.92	.92	.91	.90	1.06
Insoluble ash.........do...	.53	.36	.31	.31	.33	.28	.26	.30	.38	.32	.29	.45
Winton lead number......	3.99	3.04	2.74	2.61	2.84	2.52	2.67	2.42	2.70	2.50	2.43	3.04
Ross lead number..........	4.49	3.73	3.29	2.99	3.34	3.33	3.35	3.05	3.39	3.50	3.40	......
Malic acid value...........	1.38	1.00	.92	.85	.93	.83	.99	.87	.92	.92	.82	1.03

The southern maple-producing States, West Virginia, Indiana, Ohio, Pennsylvania, and Maryland, show higher figures than the northern States, Vermont, New Hampshire, Maine, and Michigan. This relationship becomes more evident when the figures are inserted in a map of the United States in the region from which the samples come. In the western group, West Virginia, Maryland, Pennsylvania, Ohio, Indiana, and Michigan, the sectional differences are very marked. With the exception of the Maryland figures, the drop in all determinations as one goes north is very marked. From West

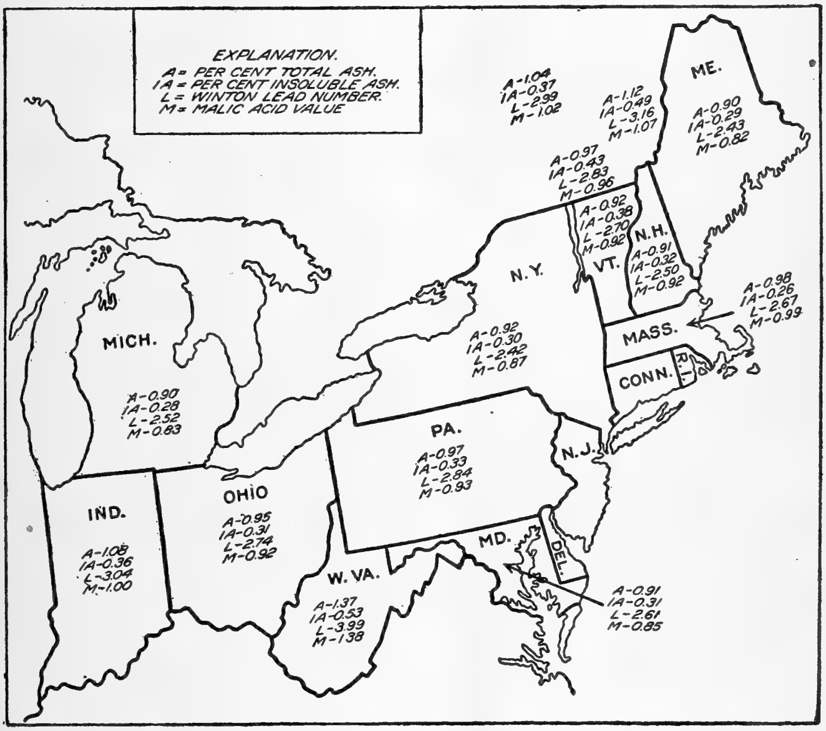

FIG. 2.—Map showing effect of environment on analytical results of maple sugar, United States.

Virginia to Michigan there is a drop of 0.47 per cent in ash, of 0.25 per cent in insoluble ash, of 1.47 in Winton lead number and 1.16 in Ross lead number, and of 0.55 in the malic acid value. In the eastern section, comprising New York, Massachusetts, Vermont, New Hampshire, and Maine, the drop as one goes north is not so great. From Massachusetts to Maine, the drop in total ash is 0.08 per cent, in insoluble ash none, in Winton lead number 0.24, in Ross lead number none, and in malic acid value 0.17.

It is evident, then, that environment plays some part in the composition of maple sugar.

CHANGES IN COMPOSITION AND COLOR FROM SAP SIRUP TO SUGAR SIRUP.

The sirup from maple sugar has a more even color and flavor than sap sirup, due to the mixing of various grades of maple sugar. It is much darker in color than that of the original sap sirup, and the taste is greatly changed, although no comparative figures along this line are available.

Ten samples of the sap sirup were collected and analyzed; a portion of the sirup was then concentrated in a glass vessel over a lamp to the sugaring-off point, stirred, and allowed to cool. The sugar so produced was again dissolved in water to the consistency of commercial sap sirup, filtered, and analyzed. In this additional concentration, in most cases, very little precipitation occurred. There was enough, however, to make the sugar sirup cloudy, but this soon settled when allowed to stand. For comparison, the figures obtained on analysis were calculated to the dry basis.

TABLE XXIV.—*Changes in color and composition from maple-sap sirup to maple-sugar sirup.*

Kind of sirup.	Color.	Sucrose.	Invert sugar.	Ash.	Insoluble ash.	Lead number.	Malic acid value.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*		
Sap sirup	10	93.83	3.68	0.78	0.28	2.19	0.75
	7	96.80	.93	.84	.24	2.26	.84
	7	96.64	.45	.90	.23	2.00	.77
	9	95.10	1.84	.94	.40	2.84	1.05
	7+	95.43	1.20	1.07	.46	3.13	1.16
	9	95.23	.71	.87	.27	2.28	.87
	8	94.26	1.43	.83	.34	2.56	.85
	8	92.93	2.63	.82	.36	2.70	.87
	9+	95.15	.81	.80	.26	1.93	.69
	8	95.82	1.10	.82	.23	1.99	.73
Average	8.2	95.12	1.48	.87	.31	2.39	.86
Sugar sirup	12	83.03	8.86	.77	.22	2.04	.62
	9	96.10	1.51	.81	.22	1.96	.60
	9	96.18	1.07	.77	.22	2.42	.61
	9+	94.18	3.46	.80	.23	2.07	.63
	9	95.24	1.49	.88	.22	2.20	.66
	11	94.90	1.40	.85	.23	2.11	.59
	9	95.60	1.70	.79	.28	1.98	.64
	9	92.88	3.68	.80	.31	2.29	.69
	11	95.25	1.11	.85	.22	1.96	.69
	9	96.11	1.32	.83	.23	2.09	.74
Average	9.7	93.95	2.56	.81	.24	2.11	.65

Taking the individual determinations as given in Table XXIV, the color increases in every case, the average increase being two colors. If this concentration had been carried on under commercial conditions, the color would probably have been influenced to a greater extent, for the boiling in this instance was carried on under the best possible conditions, in glass apparatus. In concentration, the percentage of sucrose has decreased in nearly all cases, while at the same time there is an increase in the percentage of invert sugar, showing that longer and higher heating tends to break down the sucrose.

The percentage of ash drops from 0.87 to 0.81 per cent, and of insoluble ash from 0.31 to 0.24 per cent, the lime salts evidently being the ones eliminated. The figures for the lead number show a decrease of 0.28 from 2.39 to 2.11, and the malic acid value decreases from 0.86 to 0.65, all indicating that a malate of lime is precipitated.

MOISTURE IN MAPLE SUGAR.

The percentage of moisture was determined in only a few of the samples of sugars. The percentage varied somewhat, as shown in Table XXV.

TABLE XXV.—*Moisture in maple sugar.*

Sample No.	Condition.	Moisture.	Sample No.	Condition.	Moisture.
		Per cent.			*Per cent.*
Grain sugar:			Cake sugar—Con.		
8413	Very dry	0.65	8360	Medium hard	6.28
8338	Medium dry	3.84	8362	do	6.46
8339	do	6.65	8364	do	6.78
8344	do	8.42	8366	do	9.67
8333	Soft	11.00	8367	do	7.43
Cake sugar:			8375	do	8.50
8325	Hard	4.19	8378	do	8.31
8324	do	5.28	8386	do	5.53
8349	do	8.18	8430	do	6.96
8350	do	7.35	8433	do	7.08
8351	do	5.87	8451	do	7.97
8387	Very hard	1.43	8452	do	9.45
8460	Hard	5.21	8454	do	8.57
8500	do	7.40	8501	do	6.22
8372	do	3.15	8346	Soft	10.79
8381	do	2.10	8347	do	9.64
8326	Medium hard	8.88	8348	do	10.41
8327	do	9.21	8352	do	10.60
8345	do	7.53	8353	do	10.40
8354	do	7.79	8365	do	10.66
8355	do	8.24	8374	do	10.27
8356	do	7.95	8434	do	9.88
8358	do	6.97	8463	do	11.20
8359	do	6.32	8466	do	10.44

As the percentage of water increases, the cake becomes softer, but no exact lines can be drawn on moisture content between soft and hard sugar. This depends to a great extent on the moisture content, but also on the chemical composition, that is, on the percentage of invert sugar. In general, sugars having more than 9 per cent of water are soft enough to drain badly. In fact, if most cakes with even 7 per cent of water were allowed to stand for some time there would be an appreciable quantity of drained molasses. In the 47 samples examined, the moisture content varied from 0.65 to 11.20 per cent. A former publication [1] gives as the maximum for moisture 11 per cent and the minimum 3.05 per cent. Hortvet [2] reports samples with 4.27 to 15.67 per cent of moisture, while McGill [3] reports analyses of 83 samples with a moisture content of from 0.06 to 7.06 per cent.

The method proposed by Stanek [4] with his tables, using an immersion refractometer, was the one used for this determination. The great value of this method lies in its quick and comparable results.

[1] U. S. Dept. Agr., Bu. Chem. Cir. 40.
[2] Jour. Amer. Chem. Soc., 26 (1904), p. 1523.
[3] Lab. Inland Rev. Dept. Canada Bul. 258.
[4] Zeit. Zuckerind. Böhmen, 35 (1910), p. 57; 35 (1911), p. 187.

In this method specially standardized 100 cc flasks are used. Upon their necks are etched marks showing where 100 grams of recently boiled distilled water reach, at a temperature of 17.5° C. The correctness of all readings depends on this graduation.

Twenty grams of the sample are weighed and transferred with water to one of these flasks. The sugar is dissolved by shaking, and the flask, after being filled almost to the mark with water, is allowed to stand in a constant temperature bath for 20 or 30 minutes with occasional shaking. The volume is then completed with water of the same temperature, the solution shaken, and a reading taken with the immersion refractometer, the temperature being noted at the same time with an accurate thermometer (better calibrated to one-tenth). If the temperature is any other than 17.5° C., the reading obtained must be corrected by the figures opposite the temperature in Table XXVI. For readings taken at temperatures below 17.5° C. the correction is subtracted, and for readings at temperatures above 17.5° C. the correction is added.

TABLE XXVI.—*Temperature corrections.*[1]

Temperature.	Number to be subtracted.	Temperature.	Number to be added.	Temperature.	Number to be added.	Temperature.	Number to be added.
° *C.*		° *C.*		° *C.*		° *C.*	
15.0	0.72	17.6	0.03	20.2	0.82	22.8	1.62
15.1	.70	17.7	.06	20.3	.85	22.9	1.65
15.2	.67	17.8	.09	20.4	.88		
15.3	.64	17.9	.12	20.5	.91	23.0	1.69
15.4	.61			20.6	.94	23.1	1.72
15.5	.58	18.0	.15	20.7	.97	23.2	1.75
15.6	.55	18.1	.18	20.8	1.00	23.3	1.78
15.7	.52	18.2	.21	20.9	1.03	23.4	1.81
15.8	.49	18.3	.24			23.5	1.85
15.9	.46	18.4	.27	21.0	1.06	23.6	1.88
		18.5	.30	21.1	1.09	23.7	1.91
16.0	.44	18.6	.33	21.2	1.12	23.8	1.96
16.1	.41	18.7	.36	21.3	1.15	23.9	1.99
16.2	.38	18.8	.39	21.4	1.18		
16.3	.35	18.9	.42	21.5	1.22	24.0	2.03
16.4	.32			21.6	1.25	24.1	2.06
16.5	.29	19.0	.45	21.7	1.28	24.2	2.09
16.6	.26	19.1	.48	21.8	1.31	24.3	2.12
16.7	.23	19.2	.51	21.9	1.34	24.4	2.15
16.8	.20	19.3	.54			24.5	2.19
16.9	.17	19.4	.57	22.0	1.37	24.6	2.22
		19.5	.61	22.1	1.41	24.7	2.25
17.0	.15	19.6	.64	22.2	1.44	24.8	2.29
17.1	.12	19.7	.67	22.3	1.47	24.9	2.32
17.2	.09	19.8	.70	22.4	1.50		
17.3	.06	19.9	.73	22.5	1.53	25.0	2.35
17.4	.03			22.6	1.56	25.1	2.38
17.5	.00	20.0	.76	22.7	1.59	25.2	2.42
		20.1	.79			25.3	2.45

[1] Stanek, Zeit. Zuckerind. Böhmen, 35 (1911), p. 187.

The percentage of the dry substance is then obtained from Table XXVII.

TABLE XXVII.—*Dry substance equivalent to temperature corrected immersion refractometer readings (20 grams to 100 cc).*[1]

Refractometer reading.[2]	Dry substance.	Refractometer reading.[2]	Dry substance.	Refractometer reading.[2]	Dry substance.	Refractometer reading.[2]	Dry substance.
° *C.*	*Per cent.*	° *C.*	*Per cent.*	° *C.*	*Per cent.*	° *C.*	*Per cent.*
74.0	77.35	79.0	83.70	84.0	90.05	89.0	96.35
75.0	78.60	80.0	84.95	85.0	91.30	90.0	97.60
76.0	79.90	81.0	86.25	86.0	92.60	91.0	98.85
77.0	81.15	82.0	87.50	87.0	93.85	92.0	100.00
78.0	82.40	83.0	88.75	88.0	95.10		

[1] Stanek, Zeit. Zuckerind, Böhmen, 35 (1911), p. 187. [2] Tenths of readings may be interpolated.

Subtracting the percentage of dry substance from 100 gives the percentage of moisture.

To illustrate the manner of using the tables, 20 grams of sugar made up at 15.5° C. gave a reading of 90.15. The correction for 15.5° C. is 0.58, which subtracted from 90.15 gives 89.57. The dry substance for 89.0 is 96.35 per cent and for 90.0 it is 97.60 per cent, a difference of 1.25 per cent. Fifty-seven hundredths of 1.25 is 0.71, which added to 96.35 gives 97.06, the percentage of dry substance, or a moisture content of 2.94 per cent.

Table XXVIII shows that the results by this method approached very nearly the results of the usual drying method.

TABLE XXVIII—*Moisture content of sugar by drying and by refractometer.*

Sample No.	Drying.	Refractometer.
	Per cent.	*Per cent.*
1	1.35	1.40
2	.62	.65
3	2.32	2.40
4	.85	.90
5	1.96	2.09

MAPLE CREAM, HONEY, AND WAX.

Among the numerous products made from maple sap may be mentioned maple cream (or maple butter), maple honey, and maple wax.

Maple cream is produced by boiling the sirup to a density slightly heavier than that for a soft sugar and suddenly cooling the product, stirring all the time with a large spoon or paddle. This beating and cooling tends to produce microscopic crystals of sugar which give the product a creamy appearance and do not separate out on standing if the proper density is maintained. An early run of sirup is not the best for this product, as some inversion of the sucrose is necessary to obtain the best results. This product has been called maple butter in some sections and is frequently prepared by farmers.

Maple honey is the name often given to a light-colored maple sirup which has been boiled to a density slightly heavier than that of sap sirup, or similar to that of strained honey. The sirup could hardly be an early run, but should be one in which there has been some inversion of the sucrose, for otherwise the product will soon crystallize. As this substance has no connection with bees and is never stored in combs, the fitness of its name may be questioned.

Maple wax is prepared by boiling sap sirup to a density nearly equal to that of hard sugar, but without stirring, and then pouring the product over snow or ice to secure an immediate cooling, thereby preventing crystallization of the sugar. This can be made only in small quantities and does not keep its waxy condition for any length of time.

As in the case of maple sugar, chemical examination of these products should be carried on by concentrating them in solution to a sirup with a density of 65, calculating the analytical results so obtained to the moisture-free basis, and determining the original moisture content.

CONCLUSIONS.

ANALYTICAL FIGURES OF PURE MAPLE PRODUCTS.

Moisture.—Maple sirup should have a density equivalent to at least 65 per cent dry substance or, in other words, it should weigh 11 pounds to the gallon. A thinner product does not keep, and a heavier one shows more or less crystallization, depending on the quality of the sap and on manufacturing conditions. Maple sugar with a water content much over 5 per cent is runny and drains easily. In tub sugar, the moisture content may run as high as 10 to 12 per cent, but beyond this the sugar becomes mushy.

Sugars.—Sucrose normally constitutes about 95 per cent of the dry substance of the maple product, and, together with about 3 per cent of reducing sugars, forms the total sugar content. In some samples sucrose constituted about 97.5 per cent of the product. In normal sirup, or sirup in which no acid fermentation has taken place, the sum of the sucrose and the reducing sugars calculated to sucrose by the factor 0.95 will give a figure ranging very close to 97.5 per cent of the dry substance.

Ash.—The total ash is an important figure in the analysis of a maple product. The average percentage in 481 samples of maple sap sirup was found to be 1 per cent, with extremes of 1.68 and 0.68. In the 363 samples of maple sugars, the average was 0.98 per cent, with extremes of 1.70 and 0.76 per cent, all figured to a dry basis. Examining the results on these samples critically, we find that out of the 844 samples 10 have an ash content of 0.77 per cent or lower (Table XXIX).

TABLE XXIX.—*Samples of maple products with a total ash content of 0.77 per cent or less.*

Serial No.	Total ash.	Insoluble ash.	Winton lead number.	Malic acid value.	Serial No.	Total ash.	Insoluble ash.	Winton lead number.	Malic acid value.
	Per cent.	*Per cent.*				*Per cent.*	*Per cent.*		
6680.....	0.68	0.26	2.22	0.66	7743.....	0.76	0.45	1.86	0.75
8365.....	.77	.23	1.96	.61	(1)	.77	.22	2.04	.62
8354.....	.77	.23	2.13	1.15	(1)	.77	.22	2.42	.61
8349.....	.77	.22	1.86	.92	(2)	.76	.25	1.87	.62
8351.....	.76	.23	1.85	.78	(2)	.77	.24	1.86	.60

[1] Taken from experimental work on change in color from sap to sugar sirup.
[2] Taken from experimental work on resugaring.

Thus, in the examination of 844 samples, it is noted that a total ash content of 0.68 per cent has been found in one case only, and 0.76 per cent in three cases only; all other samples give 0.77 per cent or over. In these four cases, all other figures are within those found in normal products, namely, Winton lead number 1.85 or over, insoluble ash 0.23 or over, and malic acid 0.59 or over. It seems then that percentages of ash lower than 0.77 per cent are abnormal figures and do not necessarily indicate a mixture with other sirup, especially cane-sugar sirups.

The insoluble ash analysis is of equal importance with that of the total ash. Among the sap sirups the lowest insoluble ash content was found to be 0.23 per cent, with an average of 0.37 per cent and an extreme of 1.01 per cent. Three samples of sugar sirups had an insoluble ash content below 0.23 per cent, but the average was 0.36 per cent and the extreme 1 per cent, practically the same as in the case of sap sirup. In the experimental work about five additional samples with an insoluble ash content of 0.22 per cent were found. The results on these eight samples appear in Table XXX.

TABLE XXX.—*Samples of maple products with an insoluble ash content below 0.23 per cent.*

Serial No.	Total ash.	Insoluble ash.	Winton lead number.	Malic acid value.	Serial No.	Total ash.	Insoluble ash.	Winton lead number.	Malic acid value.
	Per cent.	*Per cent.*				*Per cent.*	*Per cent.*		
8349.....	0.77	0.22	1.86	0.92	(1)	0.77	0.22	2.42	0.61
8344.....	.78	.21	1.85	.59	(1)	.81	.22	1.96	.60
8330.....	.81	.22	2.01	.77	(1)	.88	.22	2.20	.66
(1)	.77	.22	2.04	.62	(1)	.85	.22	1.96	.69

[1] Taken from experimental work on change in color from sap to sugar sirup.

All have a total ash content of 0.77 per cent or higher, a Winton lead number of 1.85 or higher, and a malic acid value of 0.59 or higher. With the possible exception of No. 8344, these samples are abnormal in their insoluble ash content but normal in the other figures. Finding only 3 samples out of 844 with an insoluble ash

content lower than 0.23 per cent and with other figures normal, it seems fair to conclude that a pure maple product should have at least 0.23 per cent insoluble ash or, if it has less, that the other figures should be above the minima.

Winton lead number.—Much stress is laid upon the Winton lead number in judging a maple product. Among the 481 sap sirups, the lowest number was 1.76, the next being 1.85, the highest 4.41, and the average 2.70. With the maple sugars, the lowest was 1.85, the highest 4.95, and the average 2.76.

TABLE XXXI.—*Samples of maple products with a Winton lead number of 0.85 or lower.*

Serial No.	Total ash.	Insoluble ash.	Winton lead number.	Malic acid value.	Serial No.	Total ash.	Insoluble ash.	Winton lead number.	Malic acid value.
	Per cent.	*Per cent.*				*Per cent.*	*Per cent.*		
6693.....	0.97	0.26	1.76	0.31	6635.....	0.91	0.27	1.85	1.68
6613.....	.88	.23	1.85	.79	6827.....	.77	.23	1.85	.72
6577.....	.80	.23	1.85	.73	6891.....	.83	.35	1.85	.80
6768.....	.78	.24	1.85	.80	8344.....	.78	.21	1.85	.59

The sample with 1.76 was abnormal in this respect, being the only one out of 844, but the other determinations are above the selected minima. The total ash in each case is 0.77 per cent or over, and in only one case, No. 8344, is the insoluble ash content below 0.23 per cent. In two cases, however, the malic acid value is below 0.60. Here one sample only out of 844 has a lead number below 1.85, and as this sample is normal in ash and insoluble ash, 1.85 should be considered the lower limit for such a figure.

Ross lead number.—This determination was not made in the case of the sap sirups. It was made in 282 of the 283 sugar sirups from the United States and in 26 of the 80 sugar sirups from Canada. Of these 308 samples, only 6 cases were noted in which values of 2.35 or lower were obtained. The lowest value found was 2.20, the highest 5.90, and the average 3.50.

TABLE XXXII.—*Samples of maple sugars with a Ross lead number of 2.35 or lower.*

Serial No.	Total ash.	Insoluble ash.	Ross lead number.	Malic acid value.	Serial No.	Total ash.	Insoluble ash.	Ross lead number.	Malic acid value.
	Per cent.	*Per cent.*				*Per cent.*	*Per cent.*		
8344......	0.78	0.21	2.20	0.59	7560......	0.78	0.27	2.31	0.67
6373......	.78	.36	2.22	.74	7512......	.78	.23	2.32	.62
6374......	.82	.39	2.25	.83	6617......	.78	.34	2.35	.62

Of these six samples it is noted that, with the exception of 8344, determinations of other values do not fall below 0.77 total ash, 0.23 insoluble ash, and 0.60 malic acid. As, with the exception of 8344, these samples are not found in Table XXXII, it is apparent that the Winton lead value also was not below 1.85. Even in the case of

8344, the one apparently abnormal sample among some 844 samples, it is noted that all of the values do not fall below the minima just given. Applying the Ross lead number determination, which has been advanced for application in particular to mixtures of maple and cane sugar sirup, to pure maple products, it would appear that 2.25 should be considered the lower limit for this value.

Malic acid value.—Some food chemists lay great stress upon this determination, the minimum value for which in sap sirups was found to be 0.21, with an average of 1.01 and a maximum of 1.82. Only 6 samples out of the 481 had a value below 0.60. In the sugar sirups, the lowest value was 0.51, the next lowest 0.59, and all the rest were above 0.60, the average being 0.93 and the extreme 1.72. Table XXXIII shows the analytical figures of the samples having a malic acid value lower than 0.60.

TABLE XXXIII.—*Samples of maple products with a malic acid value below 0.60.*

Serial No.	Total ash.	Insoluble ash.	Winton lead number.	Malic acid value.	Serial No.	Total ash.	Insoluble ash.	Winton lead number.	Malic acid value.
	Per cent.	*Per cent.*				*Per cent.*	*Per cent.*		
6693.....	0.97	0.26	1.76	0.31	6926.....	0.87	0.35	1.98	0.52
6692.....	1.01	.24	2.36	.44	6915.....	.84	.23	2.65	.21
6773.....	.77	.26	2.63	.58	8344.....	.78	.21	1.85	.59
6918.....	.89	.26	1.86	.54	8379.....	.88	.29	2.28	.51

All these samples have a total ash content of 0.77 per cent or higher and with one exception an insoluble ash content of over 0.22. The lead number in each case, with one exception, is 1.85 or higher. It then seems proper to consider that a pure product must have a value of 0.60 per cent. Abnormal products may have a value below this, but they are not abnormal at the same time in ash or insoluble ash.

Considering the subject as a whole, a pure maple product does not yield figures below the minima set. In one or two of the determinations it might give a figure below the minimum for such a determination. If pure, however, it shows in the other determinations figures which exceed the minima.

The minima set are: Total ash 0.77 per cent, calculated to dry basis; insoluble ash 0.23 per cent, calculated to dry basis; Winton lead number 1.85, calculated to dry basis; malic acid value 0.60, calculated to dry basis.

These apply also to the samples of maple sirups which Jones [1] reports as having lower minima. Of the 34 samples reported by him as being low in some particular, 6 show all figures below the minima just stated. The remainder are above in some of the determinations.

[1] Vt. Agr. Exp. Sta. Bul. 167, p. 464.

TABLE XXXIV.—*Analytical figures of six samples showing low results.*[1]

[Calculated to dry basis.]

Sample No.	Total ash.	Insoluble ash.	Malic acid value.	Water in original sample.
	Per cent.	*Per cent.*		*Per cent.*
106	0.69	0.22	0.59	30.48
119	.64	.22	.59	28.75
114	.71	.22	.56	30.69
107	.71	.21	.58	27.90
112	.71	.21	.44	31.34
108	.65	.20	.49	29.64

[1] Jones, Vt. Agr. Exp. Sta. Bul. 167, p. 464.

The first three samples in Table XXXIV show an insoluble ash content only 0.01 per cent below the minimum set. Of these three, two have a malic acid value 0.01 per cent below the minimum; the other, one that is 0.03 below. This deviation is almost too slight to consider. Although low in malic acid values, the insoluble and total ash figures of the three remaining samples, with the exception of No. 108, approach very closely the minima set. A comparison with the data in Table V (page 6) indicates that, with the exception of the malic acid value, the analytical figures of sample 108 are increased if water is added and the concentration not carried too far.

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